HIS EXCELLENCY THE RIGHT HON'BLE LORD PENTLAND,
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Governor of Madras.

Original Articles.

MATERIALS FOR A POLICY OF AGRICULTURAL EDUCATION.

BY

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> Myself when young did eagerly frequent
> Doctor and Saint and heard great Argument
> About it and about: but evermore
> Came out by the same Door as in I went.

In perusing the voluminous literature which has arisen on subjects educational, the quotation which heads this paper comes somewhat forcibly to the mind. I am not oblivious to the retort that this statement obviously raises, namely, why then add to that volume? I have failed to find an answer which satisfies myself, and am fain to admit that it is probably of the same tenor as that to the riddle of our childhood—the riddle I do not remember, but the answer was to the effect that the other donkey did so too. There are certain thoughts, however—perhaps more suitably termed criticisms—which so constantly arise in such perusals that I am tempted to assume the rôle of the other donkey and commence with a few general observations which will lead on to the more special subject of agricultural education.

In all educational institutions we have two factors—the pupil and the teacher; the former, owing to the system of teaching in classes, a multiple, the latter a single, intelligence. This condition too often offers the mental equivalent of a boat's crew. In training

a crew for a race the coach has to think of the crew as a whole and attempt to raise the average physical fitness to the highest point on the day of the race. For this purpose certain members will be over-trained or "stale," others under-trained. The system of training, consisting as it does, or did in my own college days, of combined exercise in the boat, and individual exercise, known technically as swinging, affords a certain amount of latitude in adapting this system to the individual capacities of the oarsmen. Add to this the fact that the rowing age is an age of discretion where the oarsman is capable of interpreting his own feelings and expressing them to the coach, and it becomes clear that the training for a race is a system interpreted by a coach, or teacher, who is aided and checked by the intelligences of the individual members of his crew. The similarity of the conditions of the teacher with his class, to those of the coach with his crew, is sufficiently near to mask the essential and great differences, and this similarity is emphasized by the examination system which fixes a culminating point for the education. For, just as the crew is judged by the result of the race, and as the coach attempts to have his crew in the pink of condition on the day the race is rowed, so the teacher attempts to have his class so mentally equipped on the day of the examination that it will show the best advantage. To do this he, too, adopts a system and, to the extent that the class system, by which the pupils are distributed to him, and the examination system, by which he and his pupils are judged, become standardized, that system also becomes standardized and impersonal.

The force of the comparison, however, lies not so much in the points of similarity as in the differences, and this aspect will repay a brief consideration. The crew is judged by its combined effort which is the resultant of the individual efficiencies of the members of the crew. In the case of the examination, on the other hand, there is no combined effort—the individual efficiencies are not interdependent—and the teacher will be judged differently according as major stress is laid on the average number of passes or on the standard attained by the most intelligent pupils. This difference may be expressed in another way. While the judge at the winning

post of the boat race has no personal influence on the result of the race and through it, on the coach and the system of training, the judge in the examination, in other words, the examiner, according as he frames his questions and considers the answers to test the general standard of the class or to pick out the best pupils, will have a material influence on the teacher and his system of teaching. Of the former type, the examinations, as conducted in this country, are perhaps the most typical examples, while, of the latter, the scholarship examinations, as conducted at the older English universities, afford a good illustration. The former appear to be the sounder in that it will aim at the maintenance of an average standard of the combined teaching, within the understanding of all the students, about which individual exercises, adapted to the individual intelligences, can be built. The latter type of examination forces the standard of the combined teaching to the level of the highest intelligence—too far above the level of the weaker intellects for any system of individual exercise to be of value.

Again, I have stated the members of the crew have reached an age of discretion. They are in a position to judge by their feelings their physical fitness; they can convey those feelings to the coach who can modify the individual training accordingly. The pupil is in no such enviable position. He is not a judge of his own mental condition and the teacher is, thus, to this extent at a disadvantage, when compared with the coach, that he has to interpret his instruction in terms, not of his own intelligence, but of that of his pupils. This to my mind is a point rarely realized and realized with the utmost difficulty. Again and again I have listened to reasoned and logical arguments on courses of instruction the reason and logic of which, however, appeals to the adult mind, and I have found it impossible to avoid wondering, as I listened, whether the speaker had not assumed in his pupils a mind as logical and as accustomed to reasoning as his own. The danger is, in fact, very real that, in evolving a system which is reasoned and logical, the teacher is evolving one which, by that very fact that it is reasoned and logical, will appeal to the adult and not the pupil mind. He has, in fact, failed in one of the main functions of a teacher, and he

lacks the capacity of projecting himself into the position of the pupil.

There is yet a third difference in the comparison I have drawn. The coach's efforts are concentrated on the race and on turning out his crew on the day in a condition as near physical perfection as possible. It is no concern of his if, on the evening after the race, the stroke dines not wisely but too well, and is later arrested for obstructing the police; nor does he care if another member of the crew spends the rest of the day smoking till he becomes ill. The teacher is in a totally different position with his pupil. He does not, or should not, lose interest in his pupil on the day the examination result is published, though this is perhaps too frequently the case. A teacher who does this is not worthy of the post, and it is only necessary to consider one of the objects of education, and that is, to render the individual a useful citizen, to make this clear. Education has missed one of its main functions if it will not prevent the man who successfully passes the final examination from developing into a pick-pocket.

By the above comparison I have attempted to bring into prominence one aspect of the educational problem, and one which is frequently overlooked, namely, the insignificance of the system compared with the individual. My statement that this aspect is overlooked may be called in question, and it is true that recognition is frequently accorded to the point. I cannot help thinking, on the other hand, that, in this country, as in others, in the distribution of educational finance and in the grants lavished by Government for educational development, which are largely earmarked as non-recurring and are devoted to the erection of new school buildings, too much attention is given to the numbers of schools teaching a standard curriculum, and too little to that improvement of the pay and prospects of the teachers which alone will attract a better class to the profession and thus remove the necessity for that rigid standardization which stultifies the individual initiative—so essential to real education—of the teacher.

The above considerations are of general application; that is, they apply to the educational problems of any country, but from

this point my argument proceeds along two lines, and deals more particularly with the problem as it appears in this country. The first of these deals with the type of education, as influenced by the conditions of the country, the second with the limitations imposed by the system of educational finance.

One of the functions of education has been already stated, namely, to render the individual a useful citizen. That may be a highly materialistic aspect, but the modern world is materialistic, and a country, if it is not to be left behind in the international race, must be materialistic. It is difficult, if not impossible, to find a brief definition which will cover each and every function of education, and the above will, perhaps, serve as well as any for a starting point. Now it is obvious that the world would not be a satisfactory place to live in, if everyone were educated to the clerical profession. The clerk is a useful person, but once the number exceeds that necessary to carry on the essential clerical work, there must be a number of persons who are failing to fulfil that function. It may be that there is here a confusion between education and training, but I think not, though I admit the line of demarcation between the two is not readily drawn. Education then, considered from a national aspect, must be diverse, and, in its practical aspect, consists in placing before the youth of the country the essentials for the development of the mind in a form which will leave the individual in a condition in which he will render useful service as a citizen. In former times the guiding factor in the choice of a profession was mainly parentage, the son following the trade of the father, and this is still very largely the case, especially in more backward countries. But modern thought—the result of compulsory education—is increasingly in favour of equality of chance, irrespective of birth. Within wide limits, therefore, the diversity of education should be so disposed as to place within reach of each individual a form of education suited to his probable future life. A more detailed consideration of the true meaning of this statement is desirable, since it is here, I think, that the fallacy contained in the modern claim for equality of chance, and in the various economic doctrines arising therefrom, is most readily exposed.

In the various professions by which the individual earns a livelihood, the labour expended is rewarded in very different measure in the apportionment of worldly goods, and, with the materialistic aspect of modern life, the professions tend to be judged by this standard and to be desirable in proportion to the measure of these goods received. Equality of chance in practice, therefore, implies a claim on the part of every individual to an education fitting him for the most lucrative profession. Now it is perfectly clear that the world would not be a fit place to live in if every individual were educated for the legal profession. Food and the thousand necessities of modern life have to be produced by human labour, and for that labour the education I have taken, as example, is unsuited. Equality of chance, therefore, is not obtainable by the provision of an education qualifying for the most lucrative fields of employment. The alternative, the equalizing of the reward, while perhaps not theoretically unsound, is practically unattainable. It is only necessary to attempt to picture the economic condition of a country in which the farm labourer receives, say, Rs. 1,000 per mensem,* to understand how far we are from obtaining equality of chance by this means. The fact is, such equality is an ideal, probably undesirable and, certainly, practically unobtainable. Labour of the brain always has been, and will continue to be, more liberally rewarded than labour of the hands, though change may occur in the degree of divergence. Equality of chance is, thus, a fallacy; nevertheless the idea has an underlying basis of truth. That truth is, I think, this. While, for the majority, it is desirable that an education shall be provided which will fit them to fill the station they are most likely to occupy in life, namely, that into which they are born, modern thought demands, and rightly demands, that the individual should not be bound by the accident of birth. Far from this meaning that each individual has a claim to the highest form of education, it implies that a ladder should exist by which individuals in any particular station can ascend, if so fitted, to a

* The same condition will be reached by assuming the High Court Judge to be paid Rs. 7 per mensem, the essential fact being the relation between cost of production and purchasing capacity—that is, relative, and not absolute, values.

higher one. Advancement is, thus, not an inherent right, but the reward of merit. One error running through educational discussions and educational schemes is the misplacement of these two objects of education—the conversion of the ladder provided for the gifted to a broad staircase for the mediocre. The effect of this error is to be seen in most countries, but in none, perhaps, more so than in this. The average individual is led to expect, regardless of economic laws, an education fitting him for a station into which he was not born and, in after life, a remunerative field in that station. The inevitable result is disillusion and discontent, the source of half the social unrest in this and most advancing countries.

I think we have now reached a stage in the argument which will enable us to provide a truer view of educational aim. It is that the main, and major, educational object should be to provide an education which will leave the individual a useful citizen in the sphere in which he was born. The educational ideal, contained in the above, is to inculcate in each individual that habit which is briefly and succinctly given in the catechismal saying, "to learn and labour truly to get my own living and to do my duty in that stage of life into which it shall please God to call me."* It may be argued that that attitude is incompatible with ambition, the desire to ascend, but I think not. That desire may exist alongside the ready acceptance of the fact of failure. But while I insist that this ideal should form the main object of educational policy, I am equally certain that that object will only be completed by the provision of what has been termed a ladder, but a ladder so hedged about that only those suitably equipped may ascend.

If the arguments adduced are sound, it follows that in any country the type of education most commonly found, should be

* "To do your work honestly, to die when your time comes and go hence with as clean a breast as may be—may these be all yours and ours by God's will. Let us be content with our status, telling the truth as far as may be, filling not a very lofty but a manly and honourable part."

In turning over the pages of Thackeray's "Essays and Reviews" during an idle half hour I have, since this article went to the press, chanced to light on the passage above quoted. It is one which would be hard to equal as a definition of the educational ideal.

adapted to fit individuals for the occupation most commonly practised, and it is only necessary to glance at the figures to appreciate how far education in this country is from the ideal I have outlined.

In the United Provinces "two-thirds of the population are supported by agriculture, and there is no single occupation which supports one-tenth of this number of people." In actual figures these are divisible into the following main classes :—

Zemindars, non-cultivating	500,000
,, cultivating	3,000,000
Tenants with some occupancy rights	10,500,000
,, ,, no occupancy rights	10,250,000
Sub-tenants	2,000,000
Labourers	4,500,000
TOTAL ...	30,750,000

While the latter two roughly constitute a class whose standard of living is such that the children have to begin to take a share in the family labours at a very early age, and for whom, therefore, the simplest primary education is all that can be provided, a very large proportion of the remainder occupy a position, such that the children are not compelled to earn a livelihood till the age of 17 or even later, and for whom it is desirable, both on individual and communistic grounds, to provide an education fulfilling the conditions I have laid down. I have said on individual and communistic grounds individual, because the world's progress is affecting agriculture equally with other occupations, and that man will succeed best who most clearly appreciates this progress and most quickly profits by new markets opened to him; communistic, because sound development of a community is only obtained by equality in the rate of educational progress of its several component parts, the unsoundest form of development being that where a small minority progresses while the bulk of the population stagnates.

There is thus a large community, probably larger than any other single community of the province, in a position to benefit by a suitable form of agricultural education. This state may be compared with the educational facilities provided, and in doing so care must be taken to distinguish between teaching agriculture, and education

fitting the student to return to the land. The point need hardly be laboured; the literary nature of the mass of the secondary education, unfitting the student for practical work of any nature; the location of the schools in urban surroundings, accustoming the student to a social life he cannot obtain at his home and replacing the healthy out-door life of the individual by the artificial sports of the play-ground—of which, though a true admirer, I recognize the limitations which include a dependence on companions for the supply of his physical recreations—are too well known to require further development. It is true attempts have been made to introduce agriculture into the school curriculum. These, however, come to grief from failure to distinguish between teaching agriculture and supplying an education suiting the pupil to return to the land. It is not realized that the student truly from an agricultural stock knows a great deal about practical agriculture, usually a good deal more than the master provided under such conditions to teach it, and such attempts as have been made hitherto to rectify the educational deficiencies indicated have failed from this cause.

On the first line of my argument, therefore, we have arrived at the conclusion that the present educational system totally fails to satisfy the needs of the largest single element, if not the major portion, of the community. It is true there is an agricultural college, but that is a coping stone without the underlying structure. Moreover, the position of a college will be more clearly understood when the second line of argument has been developed.

Educational effort, like every form of endeavour, is limited by financial considerations. The necessary funds are obtained in a variety of ways. In many cases, as in the older universities and public schools of England, the funds arise from endowments, a system well illustrated by the munificent gifts which have been made for education in the United States. In others, of which the primary educational institutions of England and a large proportion of those of this country are examples, the funds are provided by Government. In the former case the trustees are the sole arbiters in any question as to the disposal of the available funds, and the primary consideration is the degree to which the founders' terms

are complied with. In these cases, there is no question of a financial return, the trust is complete with the fulfilment of the conditions imposed. Where, however, the funds are provided by Government the position is different. Government is merely in the position of trustee for the country, and it is its duty to see that the country receives the fullest measure of return for the expenditure involved. It is no part of my argument to justify the expenditure of public funds on education, that is generally admitted; my concern is with the measure of the return received, with relative, rather than with absolute, values. There can be little doubt of the relative value of the two classes of education; that which, on the average, fits a man for full development in that station in which he lives and has his being, and that which compels him to seek, among fresh fields and pastures new to him, his means of livelihood. The former is a process of gradual evolution of the individual, which allows for development owing to the gradual interaction between the individual and his surroundings; the latter partakes of the nature of thrusting hot glass into cold water, a process ending usually in the destruction of the glass vessel.

The true error in the educational system of this country, as I conceive it, lies in the fact that it has hitherto developed along lines which render it unsuited for the largest single element, if not for the major portion, of the population. This is no complaint that the educational facilities are excessive, but it is a very definite statement that the fullest measure is not being obtained for the funds expended. This is not merely based on negative considerations implying merely a waste of funds, such would be the case if the schools and colleges were filled by the sons of the clerical and learned professions; it implies more than this, the expenditure of funds on directions actively harmful; for, by failing to provide an education fitting the son of the landholder to remain on the land, the system drives such persons into a line of life for which they are unfitted, and in entering which they become as the hot glass to cold water. What is needed, and urgently needed, is the development of a form of education which will leave the average country youth fitted for life in the surroundings in which he is

born; there is ample scope in such surroundings for the educated mind to find full and useful employment and to fulfil the rôle of a useful citizen which we have laid down to be one of the main functions of education.

It is open to argument that I am here labouring to prove a point, the importance of which is already sufficiently recognized. In part that is true; the recent conferences on agricultural education, the first held two years ago at Pusa, and the second last year at Simla, indicate this. The "memorandum showing what has been or is being done to impart agricultural education to the sons of cultivators," published in connection with the report of the last conference, however, shows what a relatively small amount of effort has been devoted to this aspect of education. Nor is my main object to supply this proof. I am tempted to think the difficulty has lain not so much in the recognition of the fact as in the recognition of what constitutes a suitable form of education. The arguments I have hitherto adduced may incidentally prove this point, but that proof is only incidental. Their main advantage lies in the fact that they provide a point of view which will, I think, help to point a way to a solution of some at least of the practical difficulties involved.

I have tried to show that, at least where the funds are provided from public sources, there is a very definite financial limitation to the method of disposal. This will become clearer on considering a concrete case. The Cawnpore Agricultural College has a four years' diploma course limited to 25 students per year, or a total of 100 students in residence. The college budget is Rs. 43,600, but this is clearly an under-charge, as it excludes all charges on the botanical and chemical sides, which are budgetted jointly with research, and it is merely the recurring charge without allowance for interest on capital charges or depreciation on building accounts. It is probable a figure of three-fourths of a lakh is not an over-estimate—that is, a cost of Rs. 750 per annum per student. The question is, under what circumstances is the expenditure of this sum of public money justified? It is always difficult to argue with any degree of conviction as to the justification of expenditure where the return is,

as in this case, indirect. The subject is, therefore, best approached from a different aspect, and there are two such. The first is to discover the circumstances under which that return will be a maximum, and the second to consider the class of applicant now seeking admission.

The justification of the Agricultural Department must be found, in like manner, in the improvement of the economic conditions of the country, and no doubt the expenditure on the college is justified to some extent by the necessity of training members for that department. That, however, is a minor matter, two only, out of the 25 students annually admitted, being admitted to the service. Were that the only object of the college, it would appear possible to find a more economical method of recruitment. The truth is that the ultimate justification must be found in the future career of the 23 remaining students.

Now, considered in a relative aspect, it cannot be doubted that a single zemindar, possessor of several villages, who takes a personal interest in his estate and who is progressive, by reason of a liberal education such as the college is now in a position to give, is potentially a far greater asset to the country than the small zemindar or tenant cultivating a few *bighas*. In the former case the gain is not limited to the actual money value of the better crops produced, and of the extra gain due to better business methods, great though this may be. His property forms a practical demonstration which must have some influence on the surrounding countryside, and he himself becomes an unpaid propagandist of new methods. The latter, on the contrary, can do little more than grow better and more valuable crops, and he possesses little of that which we may briefly sum up as influence. The college will be filling its function to the full, therefore, only when the main source of recruitment is the zemindar class, a class relatively small, perhaps, but numerically large and potentially powerful. It can hardly be doubted that a college with students so recruited would be in a position to do more to improve agriculture and the economic conditions of the countryside, on which that improvement so largely depends, than one with students recruited from any other source. It is

the condition in which the college will most fully justify its existence.

That, at least, is the aim I have set before myself since I have been in charge of the college at Cawnpore. It is, for many reasons, an aim not immediately realizable. The larger landholders are mostly non-resident and have more immediate interests. The smaller ones are shy and frequently insufficiently educated. For the present it is sufficient if a few only of this class come, and it is a hopeful sign that this is the case.

The majority of applicants at the present time are, nevertheless, men merely seeking Government appointment intermixed with true agriculturists, petty zemindars or tenants. Frequently the application is accompanied by an appeal for a stipend. With the former I have no concern, they are not the type of student for whom there is any opening. The latter, however, form the class to which the department looks for its recruits and the admission of a few is justified on this ground. The claim for a stipend is a different matter, and as it is here that the financial aspect receives its clearest demonstration a short digression will not be amiss.

To any one who has had to deal with the selection of students for admission to a college the frequency with which poverty, as a ground for admission accompanied by financial assistance, is advanced will be well known. The fallacy of such a claim has, as far as I am aware, never been shown up: it is certainly not generally recognized. What applies for one applies to all. Were poverty to constitute in one case a claim to admission to a college with a stipend, every youth of suitable age would be justified in demanding this concession, and the collegiate education would become the standard the State is called upon to provide. The cost, placed at Rs. 750 per annum in the case of the college, to the State is clearly prohibitive, and those persons who advance such a claim forget that the money to provide the education and stipends ultimately comes from their own pockets. The fact is that stipends are only justified in cases where poverty appears as a check to an ability, to the possessor of which a college course will open a useful and profitable career.

I have now attempted to define, by reference to the Cawnpore College, the legitimate function of such an institution. That function is, to a certain extent, based on local conditions, and is not therefore, necessarily identical with that of other colleges. The same financial consideration, however, underlies all, and the college aspect can never do more than touch on the fringe of the problem reaching as it does only the numerically smallest class of persons connected with the land. If the true function is performed, however, the college will be the means of providing, in the departmental district officers and in the progressive zemindar, two agencies of effective agricultural development. The speed of introduction of improved methods is, however, a reciprocal process dependent not only on the skill and energy of the instructor, but on the receptivity of the instructed. While, therefore, the college is providing for the former, the latter is in no way provided for. The form of education provided is too expensive for the mass, it is moreover collegiate.* What is here required is a cheap form of secondary education, complete in itself and complete within the limits provided by the age at which the average boy leaves school. In the United Provinces the sole attempt hitherto to provide an education of this type is in the vernacular two years' course of the college. The institution of this course and its location at the college is admittedly a temporary arrangement and the course suffers from many disadvantages. In the first place, the age of admission is too high for a true secondary school, being the same as for the four years' diploma, or collegiate, course. Secondly, in addition to supplying a course of instruction suited for the class which we are now considering, it attempts to meet the needs of the members of that class which I have shown the college should attract, but those members who possess insufficient knowledge of English to take that course, two aims which are incompatible. While, therefore, the course has not been without its uses, it fails in several directions to meet the needs of the situation. In other provinces greatest progress in attempts

* Or should be. Owing to the weakness of the secondary education, the teaching has to make up the deficiency and is largely secondary in character.

to solve the problem has, perhaps, been made in the Bombay Presidency where several vernacular agricultural schools are in existence. The cost of each pupil is stated to be Rs. 180 per annum, grounds which alone would place it beyond consideration for universal adoption.* The main problem, the provision of schools supplying an education fitted to the needs of the mass of the agricultural population and at a cost which makes possible their establishment in numbers sufficient for the accommodation of the available pupils, still awaits solution.

The primary object of such schools will be to raise the receptivity of the younger generation of agriculturists and the method of attainment must be through education under conditions which retain the association with the land. This is a very different proposition to the provision of vocational schools, of which the main function is to impart technical skill. In the latter, technical instruction is the primary consideration, and theory is only taught in so far as it bears on the particular trade. In the former, it is true, subjects bearing on the vocation may, and do, form part of the course, but the centre of gravity of the instruction is shifted. These subjects are taught for their internal value as a means of education, and the practical application is left to be drawn by a process of natural imbibition in the daily life. It is here, as I think, that the efforts which have been made to introduce agriculture into the existing schools have failed.

Let us consider for a moment how an agricultural school of this type would be organized. The courses of instruction are to be educational and the students are to be introduced to an appreciation of a standard of country life, something superior to the ordinary village life they have known, by a process of familiarity. Although, therefore, not directly a part of the education, the conditions and their arrangement will form as, if not a more important section of the school organization than the purely educational section, in that they will form an essential of all such institutions, while modification

* A boarding secondary school of the present type costs approximately Rs. 60 per annum for each pupil.

to suit the different grades of schools will be made in the educational courses.

I will try and bring out the main features of such an organization by a description of such a school as I conceive it. It is to offer a practical demonstration of village life under improved conditions, under which the student will live and have his being with a degree of intimacy that will render those conditions a normal part of his existence. Now the essence of village life is the family, living as a unit cultivating a certain area—greater or less according, in part, to the circumstances of the family, but, in part, also, according to the locality. Thus the holdings in the east are, on the average, much smaller than those in the west of the provinces, and allowance will have to be made for such divergencies. The school will now represent a village, the unit of communal life, composed of families, the unit of private life. Assuming a middle school with a five years' course and the maximum age 17 or 18, the students of the senior class will each represent the heads of the families which will be made up of, roughly, one student from each year, giving in all five members to each family. The school will have approximately sufficient land to provide for each "family" of five students an area, roughly, equal to the average holding of the locality. In this community the headmaster and his assistants will play the rôle of the zemindar and his agents. He will apportion the farm lands among the "families," issuing yearly leases at reasonable rents, and the "family" will then cultivate the land under his directions, actually performing the operations themselves. The next year a rearrangement of students in the "family" necessitated by the head leaving and by the introduction of new admissions, combined with a redistribution of leases, will give ample opportunity for arranging that each student will obtain practical experience, during his period of residence of each of the crops cultivated.

Before passing to the strictly educational aspect of the course, we may consider this proposal in some further detail. I have said the headmaster will play the rôle of zemindar; he will, if the scheme is to attain its full development, have to play many parts. As zemindar, I have stated, he will issue leases at reasonable rents,

It is not proposed that these rents should necessarily be paid. The headmaster should also organize the school as a co-operative society, of which the individual heads of families are members and from which the rent can be advanced. Reality can be given by the payment of a nominal sum by each "head" for membership, but the rent and most other transactions, being dues to the headmaster, may be book entries merely. Produce would be similarly pooled for disposal on co-operative principles and may even be used to supply a co-operative store to supply the necessaries of life of the students. If payment be actually made by each student or by each "head," a nominal bonus may be given, otherwise the transactions will, throughout, be nominal as regards cash values, but in all respects should conform with reality. Thus, the amount shown to the credit of a "family" for produce received should be based on the actual sum for which the produce was disposed.

The above constitutes what I may term the environmental aspect of the school; the educational aspect may now be considered. This is an aspect which, more than any other, suffers from the danger of dogma, and, in the present case, it in no way differs from the general problem as it appears in all educational institutions. It is a problem to which each individual will offer a different solution depending on his particular personal bent. Such solution as I shall offer is, therefore, of necessity so coloured. Education as found in this country fails in two directions—the first, practicality; the second, accuracy. With the former I have already dealt; the whole organization of the environment is aimed at developing this character. The latter must be developed in the class-room. For this purpose the following subjects seem best fitted: mathematics, associated with which may be book-keeping and accounts, and elementary physics. With these subjects emphasized, the remainder of the course will be composed of those subjects which form the basis of the curriculum of the ordinary school, preference being given to subjects which have some association with the life the students lead. Care, however, must be taken to teach each as a balanced subject without undue prominence given to their supposed practical aspects. Among such subjects I should place English, geography,

physiography and elementary studies of plant life. In the above course—and it is not desirable to go into greater detail at present—my main object being to develop principles rather than detailed schemes, the only direct point of contact between the environmental and educational sides of the school lies in the accounts, for which the books of the institution may well be used to provide practical examples. A comparison of this outline with, for instance, the curriculum of the Loni School, will bring into prominence the difference I have tried to emphasize.

A pupil taking five years to pass through such a course would thus gradually imbibe the practical aspect of agriculture; would be gradually introduced to those conditions which tend to place the cultivator in a position of sturdy independence and self-reliance, and should, by the end of his school career, be fitted to return to his home and the reality of life with a sense educated to realize the more backward conditions and a will to remedy them—a condition of mind and body suggestive of a career as a useful citizen. The information will, moreover, be learnt by a process of absorption from constant association, one of the essential conditions if the soundness of my contention is admitted.

There remains the question of cost, the question whether the scheme will satisfy the second or financial consideration, which it must do if it is to justify the expenditure of public funds involved. With 30 students in each class, a school of 150 will be formed for which an area of 150 acres' cultivation will be required if each holding is calculated at 5 acres. As most of the labour will be provided by the students, the labour bill will be small and the profit on cost of production should be considerable. In addition, there will be the capital charges and the cost of instructional staff. The former will be larger, but the latter not necessarily greater than the same charges of a school of the same standing but of the usual type. The unknown factors at the present stage are too numerous to make it possible to draw up a balance sheet which would approach any degree of probability to the actual, but it seems more than probable that the cost would be, on the balance, low. One point at any rate is clear; unless the farm is working at a profit, and a handsome

profit, it will not be fulfilling its function, and we have here, therefore, a very simple and practical test.

One point remains to be considered, and it arises from what I have said early in this article, in bringing out the difference between the coach and the teacher. However good the system is, it will never succeed in producing the desired result unless the agent, in this case the teacher, is competent to develop its potentialities. The aspect requires no enlargement, as its essential nature appears to be fully recognized and formed the subject of much discussion at the Simla Conference. For the present purpose it is sufficient to point out that the supply must be derived from the Agricultural College and forms a third legitimate field, additional to the two already described, of activity for the college.

The proposals outlined above constitute a scheme for providing for the educational needs of the largest section of the community, and, as far as considered, suffices for the main educational function, to fit the average youth for a useful and contented life in the conditions under which he was born. There remains the second aspect, without which no educational system can be considered complete, that of providing a ladder by which those intellectually qualified can arise. If such a ladder is to be provided, it follows that a system of secondary schools leading to the University or to the Agricultural College must be introduced. On this subject the Simla Conference showed considerable diversity of opinion, and the probability is that the exact direction in which this will develop cannot be forecasted with any degree of certainty, and will depend on the exact form of school that is found to succeed. I will content myself with noting a single point. The type of school I have outlined contemplates the performance of the field-work by the pupils, each holding possessing a body of pupil labourers of decreasing age. If such a scheme is to succeed, and the practical work is to be carried out with that efficiency which will alone ensure success, the oldest pupils must have attained a physical development enabling them to do the more arduous field labour. That consideration would seem to indicate that greatest efficiency will be developed in those schools where the age limit is relatively high, and hence that the type is

best adapted to schools of the secondary class. The absence of the necessary physical power in the students of the Loni School was one of the points that struck me most forcibly in the one visit I was privileged to make to that school. It would appear possible that schools of this type would lead directly to the college, and that the ladder we desire would be provided in this manner. The truth is that the practical difficulties, not the least of which is the absence of teachers, are such that the development of such schools must be slow and will afford ample opportunity for gaining practical experience. It is not desirable, therefore, at the present time to enter in too great detail into such matters. It is essentially a case for trial and experiment, the establishment of a few schools of the type described and their gradual extension in that direction which experience shows to be most desirable. What is essential is a clear comprehension of the fundamental principles which underlie the problem--a comprehension so sharp that it can be used as a test during each stage in the experiment. To the best of my ability I have attempted to supply the materials for such a test.

PRESENT POSITION AND FUTURE PROSPECTS OF THE NATURAL INDIGO INDUSTRY.

IV. THE EFFECT OF SUPERPHOSPHATE MANURING ON THE YIELD AND QUALITY OF THE INDIGO PLANT.

BY

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In a preceding article[1] I pointed out that owing to the rapid impoverishment of the Bihar indigo soils during recent years the position of the indigo industry has become very critical. When the Java variety of plant was first introduced into Bihar extraordinarily high yields of indigo were obtained—sometimes as much as 30 to 40 seers of 60 per cent. indigo per acre—but after two or three years the yield of indigo began rapidly to decline. The mysterious disease "wilt" appeared in 1907, characterized by the partial or complete loss of the *khoonties* or second cuttings and failure of seed crops. In my last article I showed that the failure of crops was progressive, becoming more and more marked each year until, in some cases, the yield of indigo was reduced by nearly two-thirds. Not only was there an increasing failure each year of khoonties, but the *moorhan* crop became of inferior quality and yielded less produce. In the years immediately preceding the war, as indigo became a less and less paying crop, the area under indigo was greatly reduced, and this to some extent relieved the situation by giving the soils a chance to recover, but the greatly increased growth of indigo which followed the outbreak of war in 1914 and

[1] *The Agric. Jour. of India*, vol. XIII, page 441. (*Indigo Publication* No. 2.)

its continuous cultivation during the past four years has again created a critical situation.

A year ago, from a detailed study of the indigo soils of Bihar,[1] I concluded that "*unless superphosphate manuring is generally adopted, an enormous falling off in the output of natural indigo will occur during the next few years*," just at the time when it is essential that produce should be at a maximum in order successfully to compete with the synthetic. This prophecy, I regret to say, has been realized this season at most factories. From reports which have been sent to me of the results of this season's moorhan mahai, *in many cases the produce obtained has only been about one-half that obtained in the corresponding mahai last year. Even where there has been a fair yield of actual green plant per acre, very little dye could be extracted from it.* In several cases the produce per acre has been less than 5 seers of cake indigo from Java plant, which, compared with the yields of 30 to 40 seers which were obtained in the early days of the introduction of this plant in Bihar, is lamentably small. As one planter has put it, "*The produce this year as well as the crop have been the worst on record.*"[2] In my last article I emphasized[3] that in the year 1917-18 the average yield of indigo per acre in Bihar fell off by nearly 20 per cent. as compared with 1916-17; this year, as I feared, the yield per acre will be far less than in 1917-18.

There is no doubt that the climatic conditions this year have been very unusual, and a series of analyses made of the growing plant, which will be published later, shows that the indican content of the leaf has been unusually low. But that the principal factor in determining high yields of indigo (not merely of green plant per acre, but the produce from it) lies in the nature of the available

[1] *Indigo Publication* No. 1, page 66.

[2] In this particular case the actual indigo obtained was of far lower *quality* than that made last year. Whereas last year the indigo made at this factory was very high grade, a large proportion containing more than 70 per cent. of indigotin, seven samples out of the fifteen analysed by me this year contained less than 55 per cent., and only two samples contained more than 60 per cent. It is very significant that *all* the best dates were from Sumatrana indigo and *all* the worst (in these the indigotin was less than 50 per cent.) were from Java indigo.

[3] *The Agricultural Journal of India*, vol. XIII, pt. II, page 451. (*Indigo Publication* No. 2, page 10.)

foodstuff *in the soil* at the time the plant is grown appears clear from the results which will now be recorded.

THE EFFECT OF SUPERPHOSPHATE MANURING ON THE YIELD OF INDIGO PLANT PER ACRE AND ITS RICHNESS IN INDICAN.

During the past season only a very few planters made trials with superphosphate manuring on their estates. But where such experiments were made the results were very favourable and fully confirm the view I have so frequently expressed that the depletion of available phosphate in the soil has been the principal cause of the failure of indigo crops in Bihar of recent years, and that by proper manuring it will be possible again to obtain the high yields of indigo which were given by the Java plant when first introduced into Bihar. The following cases may be quoted:—

(1) Mr. L. W. Lydiard of Nawada, Champaran, reported on 6th June, 1918:—

"I sowed 4 acres of Java in lines for a seed crop in the first week of August (1917) and put in super a week before sowing. I got about 4 maunds an acre of seed* and cut the crop down at the end of March and have now *splendid* khoonties in the 4 acres, which I shall be cutting next week, 3 feet high. I also 'supered' 5 acres of general crop Java, putting down the super at 2 maunds an acre, middle of September; sowed *gram* and Java ten days later and got a very heavy Hatthia rain on it. Thirteen acres were sown at the same time (that is 8 acres without super, 5 with). **The gram crop was good in the five acres with super and a failure in the eight acres. The indigo is magnificent in the five acres and wretched in the eight acres.** The lands are of one and the same sort and last year *all of it gave a poor crop.* I am getting three or four times the quantity of super this year. If only

* This is an unusually good yield at the present time. Most estates yield no seed at all or only about 1 maund per acre.

super were available at pre-war rates, I should put it in all my *zerat* lands."

(2) Mr. A. W. Fremantle reported on 12th July, 1918:—

"I tried superphosphate to a small extent last season—*the one acre (with super) gave 12 carts per acre moorhan as compared with the acre next to it which gave 6.* The rest is in *makai* (maize) and *bhadai dhan* (rice) land and the increase remains to be seen."

(3) Mr. E. Moore of Barah, Champaran, reported, on 9th April, 1918, the results obtained by growing Java indigo for seed, in one case with superphosphate only, in the other with cow-dung as manure. The details are as follows:—

(*a*) *With super*: Barra Dih Zerat. Two bighas. Super applied 1½ maunds per bigha, July 19th, 1917. Indigo sown August 6th. Total yield of indigo seed = 6 maunds 35 seers, that is *3 maunds 17½ seers per bigha.* The plant was only slightly diseased and grew to the height of about 4 feet.

(*b*) *With cow-dung only*: Mohowahwara Zerat. Eight bighas. Manured with cow-dung, and indigo sown for seed crop on 18th July. Total yield of seed from the 8 bighas = 6 maunds 15 seers (*that is only 3.2 seers per bigha*). The plant was badly diseased and about 3 feet high.

It is clear from these results that manuring with cow-dung alone is not sufficient to ensure a good crop of indigo seed under present conditions of the soil.

(4) Mr. F. B. Robinson of Sagrampur, Bhagalpur, writes (23rd August, 1918): "I experimented with this manure (superphosphate) this year and with lime, having 12 plots each of $\frac{1}{10}$th acre. *The plots (two in number) which had super in them were the only ones that yielded any sort of crop of indigo.*" In a later letter Mr. Robinson writes (15th September): "The effect of superphosphate was wonderful, and I shall manure several acres this year." Mr. Robinson gives the following summary of

the results obtained on the small experimental plots (each $\frac{1}{10}$th acre in area).

Manure on plot	Produce	Remarks
5½ seers super	5¼ bundles plant	Plant 3 feet high and very leafy
5 seers super	5 ,, ,,	Ditto
17 mds. lime per bigha	1 bundle ,,	About 1 foot high, hardly any leaf
8½ mds. lime per bigha	1 ,, ,,	Ditto
No manure	1 ,, ,,	Ditto

The analyses of the Sagrampur soils are given in *Indigo Publication* No. 1. They differ very strikingly from most of the Tirhut soils in being very deficient in lime as well as in phosphate. Manuring with superphosphate at the rate of $1\frac{1}{4}$ mds. per acre increased the yield of indigo five-fold, whereas the addition of lime alone gave no increase of crop.

(5) The most striking results with indigo, however, were obtained by Mr. G. Moore of Moniara, Saran.* On June 5, Mr. Moore reported:—"As regards superphosphate, after green-manuring with *sannai* I applied super and I am pleased to tell you the lands treated *thus have a splendid crop of Java and it was poor land. I also kept a chakla fallow, of good quality: the Java on this is not so good as the other.*"

* Mr. H. L. Russell of Suddowah, Saran, has reported the effect of superphosphate on oats during the past season (5th June, 1918): "Just a line to tell you that on the few bighas of oats where I put down superphosphate my outturn was 7½ maunds per bigha. My total outturn on the rest of the lands was 4¾ maunds the bigha." It should be noted that owing to the failure of rains in the cold weather of 1917-18, the yield of oats throughout Bihar has been exceptionally poor. Colonel V. N. Hickley (3rd May, 1918) has sent me the following details with regard to the effect of super-manuring on the oat crop at Ottur.

		Average return of oats per bigha	
		Maunds	Seers
Season 1915-1916	.. No seed but 2 maunds super per bigha	12	21
,, 1916-1917	.. ,, ,, ,,	11	3
,, 1917-1918	.. No super, no seed	5	1

As already stated the oat crop was poor in Bihar this year owing to lack of winter rains, and Colonel Hickley states that "in a normal season the outturn without super should have been 8 maunds per bigha."

At my request Mr. Moore made arrangements separately to mahai the indigo grown on the land manured with super and sannai, so as to compare the produce obtained from such plant with that grown on the same estate and at the same time under other conditions of treatment. On July 17, Mr. Moore sent me the results given in Table I (pp. 40-41). On this date he reported:—"I had very fine Java plant this year, but the *best crop was on the land green-manured and treated with super afterwards—not very high, between 5 and 6 feet, but covered with leaf.*" On August 23, he wrote:—"Khoonties I am sorry to say were a wash-out this year. *What there are though are on the super-treated lands which is satisfactory.*" Mr. Moore's results are particularly valuable in showing the enormous effect of proper manurial treatment on the *quality* of the indigo plant—that is, its richness in indican and the "produce" it yields. As this side of the question has hitherto been largely overlooked, although of supreme importance, it is desirable here to consider the results in some detail from this point of view.

The effect of manurial treatment on the quality of the indigo plant.

The following Table (II) abstracted from the data in Table I shows the yield of green plant per acre, the weight of cake indigo obtained per acre, the yield of cake indigo per 100 maunds of green plant, and the weight of green plant required to produce one maund of cake indigo under different conditions of manurial treatment.

TABLE II.

Yields of indigo from Java plant at Moniara under different manurial conditions.

Date of mahai	Treatment of land	Acres cut	Average yield of plant per acre	Average yield of cake indigo per acre	Quality of plant: Yield of cake indigo per 100 mds. plant	Quality of plant: Green plant required to produce 1 md. indigo	Remarks
			Mds. Srs.	Srs. Ch.	Srs. Ch.	Mds. Srs.	
June 17 ...	Kept fallow 12 months ...	10·47	95 12	10 5	10 14	368 0	This land was of better quality than that treated with super and sannai
,, 18 ...	Super and sannai	9·60	94 6	13 2	**13 15**	**284 20**	Steeping with very cold water (83°F.)
,, 19 ...	Jamoona Singh's *khuski* ...	2·40	208 20	16 12	8 0	497 15	Java grew to tremendous height in these two fields—8 feet—but more wood than leaf
,, 22 ...	Manured with seet water ...	3·05	218 28	14 12	6 11	593 0	
July 4 ...	Super and sannai	4·01	**153 1**	**32 4**	**21 1**	**189 20**	Height of crop 5 to 6 feet. Covered with leaf from top to bottom
,, 5 ...	Seet dug in with *kodali* ...	8·29	79 34	12 10	15 13	252 10	
,, 6 ...	Seeted land sown in February, along with Sumatrana	7·85	119 32	16 15	14 2	282 10	
,, 7 ...	Seet dug in with *kodali* ...	13·09	84 11	11 7	13 10	233 0	
,, 8 ...	Java of Bhoji Chaper mixed with February sowing	10·04	88 23	13 3	14 15	267 10	
,, 9 ...	February sowing of Java	13·83	72 24	6 5	8 11	458 20	
,, 10 ...	February sowing and Hiranda plant	12·22	78 4	11 2	14 4	279 20	

The following points stand out very clearly as regards the effect of conditions of growth on the *quality* and yield of produce :—

(*a*) In the early June cuttings, a fortnight after the break of the rains, the *quality* of the plant grown on super and sannai was far higher than that grown under other conditions, as shown by the highest yield of cake indigo per 100 maunds of plant* (*viz.*, 13 seers 15 chataks). But at this stage the plant grown on super and sannai was not fully developed and the yield of green plant per acre was lowest (94 maunds per acre). There was an enormous growth of plant on the *khuski* land and on the land manured with seet-water, but although the plant was very tall it was of poor quality and contained little leaf.† The consequence is that the yield of cake indigo per 100 maunds of plant was very small (8 seers 0 chatak and 6 seers 11 chataks in these two cases). On the land manured with seet-water there was a rapid *forced* growth of indigo, and the plant grew to a great height (8 feet), but there was very little indigo in the plant. The consequence was that it took 593 maunds of green plant to produce 1 maund of indigo as against 284 maunds of the *rich* plant grown on super and sannai.

The plant grown on super and sannai was very much better in *quality* than plant grown on *better* land which had not been treated with manure, but left fallow for 12 months—as shown by the yield per 100 maunds of plant being 13 seers 15 chataks as against 10 seers 14 chataks. Thus although the actual yield of *plant* per acre was slightly less (94 maunds 6 chataks as

* On the day this plant was worked the conditions were, too, most unfavourable for a good steeping, the water being exceptionally cold (83°F. instead of the customary 90°F.).

† The growth on these lands was forced by the high proportion of nitrogenous food in the soil. It grew to a great height (8 ft.) but the lower leaf was rapidly shed in consequence of unbalanced growth. As a result the plant in June largely consisted of stick and it gave a very poor yield of indigo. On the other hand, the plant grown on super and sannai although fairly tall was covered with leaf from top to bottom.

against 95 maunds 12 chataks), the actual produce of indigo *per acre* was considerably higher (13 seers 2 chataks as against 10 seers 5 chataks).

On June 18th, however, the plant grown on super had clearly not reached maturity and was not really ready for cutting. This is shown by the greatly increased yields obtained when the same plant was cut a fortnight later (July 4). Consequently at the earlier stage (June 18) the yield *per acre* (13 seers 2 chataks) was somewhat less than in the case of the khuski crop and the land manured with seet-water (yields 16 seers 12 chataks and 14 seers 12 chataks per acre, respectively) where there was an enormous, *rapidly grown crop* of poor quality.

(*b*) In the interval between June 18th and July 4th, there was heavy rain (15 inches) followed by a dry spell between June 27th and July 4th. In this period the plant grown on super and sannai developed considerably—the yield *per acre* increased about 60 per cent. (from 94 maunds 6 seers to 153 maunds 1 seer), whilst the *quality*, judged by the yield of indigo per 100 maunds of plant, was increased also to the same extent (from 13 seers 15 chataks per 100 maunds of plant to 21 seers 1 chatak). By the first week of July not only **was the actual yield of green plant per acre far higher in the case of the super-treated land, but the quality was also far superior, so that the yield of cake indigo per acre reached the phenomenal value of 32 seers 4 chataks per acre for a single cutting.**

This value is from 2 to 3 times that obtained from plant grown on the seeted land and mahaied at practically the same time (July 5th, July 6th and July 7th).

(*c*) The figures given for the average yield of cake indigo per acre *dispose of the view frequently taken by planters that the low yields of indigo recently obtained on most estates are due to deterioration of the Java indigo plant.* It is clear

that when the soil conditions are favourable (and these favourable conditions can, I consider, be largely assured by proper manuring) enormous yields of indigo can be obtained even in a year of unfavourable climatic conditions and with the existing Java plant. The yields per acre of 153 maunds of green plant and 32 seers of cake indigo for a single (moorhan) cutting far exceed the yields obtained from the Java plant in its palmiest days—shortly after its introduction into Bihar. Thus in the case of the extraordinary yield of 41½ seers of cake indigo per acre obtained at Bhagwanpur[1] in 1906-1907, this was made up of *three* cuttings, which gave respectively 14 seers 9 chataks, 17 seers 4½ chataks, and 9 seers 12 chataks. Such a yield as 32 seers of cake indigo from a single moorhan cutting is, I believe, almost without precedent. The actual yield obtained at Moniara on land treated with super and sannai far exceeded my most sanguine expectations of what could be accomplished in a single season by proper manurial treatment. It cannot of course be expected that *all* lands will respond at once in the same marked way to manurial treatment, but it appears to me certain that the majority of lands in Bihar can, by steady manuring for a few years, be made to yield 20 to 30 seers of indigo per acre *in the course of the two mahais*. This result will be attained not merely by increasing the yield of green plant per acre, but largely by improving its quality, that is by allowing the plant to grow under conditions which bring about a maximum content of indican in the leaf.

It is not sufficient merely to obtain a rapid and abundant growth of green plant. Such a growth may be obtained by manuring with soot or soot-water, or other

[1] *The Agricultural Journal of India*, vol. XIII, pt. III, p. 446. (*Indigo Publication* No. 2, p. 6.)

nitrogenous manures, such as cattle manure or oilcake. But the general experience of planters is that plant grown under such conditions has "nothing in it," and fails to yield good produce. This view is confirmed by the results in Table II obtained on June 19th and 22nd, where there was a phenomenally large growth of plant in two fields (208 and 218 maunds per acre for the first cutting) but the produce per 100 maunds of plant was very low (8 seers and 6 seers respectively).*

From the results at Moniara it would appear that a combination of green-manuring with sannai and superphosphate is an ideal one to ensure not only a high yield of plant, but also high quality. Whether this is so in general can only be decided by actual trials on the large scale. Unfortunately at Moniara no trials were made for comparison with superphosphate alone. There is the danger that abundant green-manuring with sannai may encourage rapid and forced growth of plant at the expense of quality. That this was *not* the case at Moniara, and that the nitrogenous constituents of the sannai only came slowly into action without forcing growth, is shown by the fact that on June 18th the yield of green plant per acre (94 maunds 6 seers) was only the same as on the fallow land (95 maunds 12 seers), whereas on the seeted and khuski land the yield of green plant at the same date was double as great (218 and 208 maunds respectively). But in the fortnight from June 18th to July 4th, the plant grown on the land treated with super and sannai, grew rapidly and also improved enormously in *quality*. The final plant obtained, however, was never so tall as on the seeted lands in

* Compare also Rawson's data (Report, page 13)—By manuring with seet (5 tons per acre) the yield of plant *per acre* was nearly doubled, but the produce per 100 maunds of plant halved, so that the yield of dye remained practically the same as on unmanured land.

June—it only reached a height of 5 to 6 feet as compared with 8 feet on the seeted lands—but *it was covered with leaf from top to bottom, and the leaf was obviously very rich in indican.*

(*d*) Some planters seem inclined to attribute the abnormally low produce obtained this season—a result which last year I foretold would occur—to abnormal climatic conditions, rather than to the real cause, which I consider is the exhaustion of the soil of its available phosphate supply. That the climatic conditions have been abnormal is very true—a very early break of the monsoon (June 1st) followed by an interval of 10 days without rain, then a heavy downpour on June 23rd and 24th again followed by a 10 days' break. Between July 5th and 11th, 8·39 inches fell at Pusa, and then there was another prolonged break from the 16th to 26th with heavy showers from July 27th to August 1st. From August 2nd to 5th no rain fell, but the 6 days from August 6th to August 11th were very wet with 14·00 inches of rain.

But the fact that even in this abnormal season,* on the land manured with super and sannai at Moniara, such

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* There was practically no winter rainfall in 1917-18. At Pusa up to June 1st, the rainfall was 4·47".

From June 1st to June 5th	2·48"
,, ,, 6th to ,, 8th	2·90"
,, ,, 9th to ,, 11th	0·70"
,, ,, 12th to ,, 22nd	0·74"
(A break of 10 days in which only slight showers occurred on 8 days.)	
From June 23rd to June 24th	4·61"
,, ,, 25th to July 4th (break of 10 days)	0·07"
,, July 5th to July 7th	0·84"
On ,, 8th	5·16"
From ,, 9th to 11th	2·39"
On ,, 12th	0·00"
From ,, 13th to 15th	1·52"
,, ,, 16th to 26th	0·03"
	(Ten days' break.)
On .. 27th	0·76"
,, ,, 28th	0·00"
From 29th July to 1st August	1·01"
,, August 2nd to August 5th	0·00"
,, ,, 6th to ,, 11th	14·00"

an extraordinary yield of indigo as 32 seers per acre could be obtained *in a single cutting* even with the present Java plant shows that the *principal* factor is apparently the *soil conditions*.

Manuring with sannai and superphosphate produced not only the maximum yield of green plant per acre, of all the Java indigo cut between July 4th and 10th, but also by far the *best quality plant*. The *quality* is clearly as important as, if not more important than, the *quantity*. The writer has in progress, in collaboration with the Imperial Agricultural Bacteriologist and Imperial Agriculturist, a number of experiments which are designed to throw light on the best methods of growing indigo to ensure not only a maximum yield of plant, but a maximum indican content. The plant is being grown under different conditions of manuring, and the changes in quality followed by analyses of the leaf and the proportion of leaf on the plant from time to time. When the plant is cut it is possible to calculate the actual potential yield of indigo from the proportion of indican in the leaf and the actual yield of green plant per acre. The results of this season's trials will be published in detail later.

THE REASONS FOR THE RAPID IMPOVERISHMENT OF INDIGO SOILS DURING THE PAST 20 YEARS.

Many planters find it difficult to understand why soils, which grew indigo successfully for 100 years continuously, apparently suddenly, during the last 20 years, have shown marked signs of deterioration. It is not, I think, generally realized that after 1897, the year when synthetic indigo first began seriously to compete with indigo, a complete revolution took place in the methods of indigo cultivation in Bihar. The following sketch based on information kindly imparted to me by Bernard Coventry, Esq., C.I.E., will indicate the general nature of the changes which have occurred and have been responsible for a far more rapid exhaustion, in twenty

years, of the indigo soils than occurred under the old system of working in a century.

Under the old system, up to 1897, the planter took in farm (*thikadarry*) whole estates from Indian landlords usually on a 9 years' lease, very frequently paying down in cash the whole of the 9 years' rental called *zurpaisky* or *surzamanath*. He took into indigo such lands as the landlord had in his own possession, and he contracted with the tenants for from one-seventh to one-tenth of his holding to be sown in indigo. This contract was either on the *asamiwar* system as in Champaran, where the tenant kept possession of his land and grew the crop, or on the *dehai* system as in the districts of Muzaffarpur, Darbhanga and Saran, where the contract was for the planter to prepare the lands and grow the crop himself. It is to be observed that under this system villages or estates were *constantly coming in or going out of lease* and large sums of money were yearly being expended in the shape of rent-in-advance (*zurpaiskies*) paid to the landlord for these leases. *This constant renewal was made easy by the unlimited financial facilities afforded at that time by the Calcutta Agency Houses*; indigo being then a flourishing monopoly industry their money was absolutely safe. When the lease of a village expired it did not necessarily go out of indigo cultivation: frequently the lease was renewed as before and the rent-in-advance paid down in cash. But there was always each year a number of cases where the renewal was not made and the lands went out of indigo only to come back under a fresh lease a few years later. In those days, there was also a certain number of quite new villages coming into fresh lease every year. The two important features to be observed in this system are, first, that the planter was financed to any limit by the Agency Houses which enabled him to treat for the lease of villages or estates with ease and on profitable terms, and, secondly, that *the large number of first leases and of leases renewed some years after the villages had been returned to the landlords, contributed towards keeping up the indigo-producing power of the lands.*

But, further, it was the custom to exchange indigo lands for cultivators' lands on a very considerable scale. Every year the

assistant would go round the cultivation before mahai when the indigo crop was in the ground, and indigo lands which showed the appearance of being worn out he would there and then measure. He would then, in agreement with the cultivators, measure an equal area of their lands and the exchange would be made for the next crop. This exchange was to mutual advantage and was recognized to be so by the cultivator who knew that indigo lands gave him a heavy crop of wheat, etc.

The total area thus affected by the leasing of villages and the *budli* or exchange mentioned would roughly approximate to one-fourth to one-third of the cultivation per annum at Dalsing Sarai. These favourable aspects do not now exist in their entirety. When synthetic indigo began seriously to compete with natural indigo, the Agency Houses tightened their purse-strings, not only in respect of money required for advance rent for leases, but also in respect of ordinary current expenditure. *This deprived the planter of the command he formerly had on the acquisition of fresh land for growing the crop, and it also compelled him to change his methods of cultivation.* He was now obliged to grow country crops (which he had never done before for profit-earning) on a portion of the lands on which he formerly grew indigo. He did this principally for two reasons - in order to establish a system of rotation to replace the means he formerly had of the easy renewal of leases which had now been taken from him, and in order to find money for current expenditure for such portion of the lands as remained in indigo. This arrangement, however, had not beneficial effects equal to the advantages of the old system, nor did it compensate for these. This will be clear from the following considerations.

Under the new system of cultivation imposed by the changes referred to, the planter restricted his area under indigo and introduced country crops. He did not, however, generally speaking, grow the country crops himself, but gave out to tenants the lands, usually manured with seet, on which they grew the crops. The tenants gave the planter either rent or a share of the produce which yielded a greater profit than indigo so far as these particular manured lands were concerned. He also let out into country crops some of

the lands for which there was no seet available, naturally on less favourable terms.

It must be observed that the first effect of this system was to lessen the amount of seet owing to the restricted area under indigo, so that although at first, when there was a plentiful supply of seet, this method promised well, it has gradually led to disappointment, because the area which can now be treated is often so small that the average profit earned on the whole area under country crops is exceedingly small, and sometimes even represents a loss. With the increasing failure of the indigo crop and the lack of seet as a manure which this entails, the present system promises disaster in the next few years. The system has moreover other imperfections. The lands are usually given out to cultivators for three or four years. The aim of the cultivator is to "milk" the land so as to make all the money he can out of it and return it to the planter in an exhausted state. Further, the seet which is given to him aids in the process, for being a manure with an excessive amount of nitrogen, it tends to draw unevenly on the available supplies of phosphoric acid already in defect, and makes the deficiency worse.[1] When introducing this system the planter abandoned the old custom of budli because he grew indigo only in lands which were expected to give a full crop—though in this he has been disappointed also, owing to the development of the so-called "wilt." He finds too that wilt now prevails in lands taken in budli.

I would also emphasize the fact that the "series" of crops grown has not in most cases been a true rotation at all. In a proper rotation the selection of crops is such that the fertility of the land is maintained by establishing a balance between the constituents removed by the crops and those liberated by the ordinary soil changes in successive years. The leguminous crop which always forms part of a proper rotation renovates the soil by replacing nitrogen. But in the case of the planters' lands the crops grown have simply continuously *stripped* the soil of the constituent which they especially lack—available phosphoric acid. Thus to take an

[1] *Indigo Publication* No. 1, pages 36-38.

actual example of a field which was formerly let out to ryots for cultivation, the series of crops was:—

1913	...	...	... Winter crop, tobacco.
1914	...	...	... Maize followed by winter crop of wheat.
1915	...	...	... Maize with *rahar* as *rabi* crop.
1916	...	...	... Maize followed in October with indigo and mustard together.

It was not surprising to find after this continuous stripping for several years (the earlier record whilst the land was in the ryot's hands is not known) without any application of manure, save one dressing of cattle manure in 1913, that this particular soil when analysed in 1917 contained only 0·037 per cent. of total phosphoric acid and 0·0006 per cent. *available*, even in the top 6″. On many other fields on the same estate the *total* phosphoric acid in the top layer exceeded 0·1 per cent., whilst the *available* was 0·001 to 0·002 per cent. in the *surface* layer. It was also not surprising to find that the indigo and mustard sown in 1916 did not thrive—the mustard dying out completely some time after germination and the indigo following suit.

In the old days, when indigo was grown as the sole crop, the land was ploughed several times and fallowed for a long period. There was no crop in the land from September up to the following February, when the old Sumatrana indigo was sown, during which period—the dry weather—there was ample opportunity for bacterial action in the soil to liberate a fair supply of mineral plant food. Only the one crop—indigo—was grown in the year. Under the present system *two* crops are frequently taken out in the year, when indigo is not grown, and these are often very exhausting crops—such as tobacco. When Java indigo is sown in October, it frequently immediately follows another crop, either of indigo or some cereal such as maize, without the soil having a chance properly to recover. With Java indigo, which remains on the land for nearly a whole year (October to September), two or more cuttings are taken which is equivalent to growing two ordinary crops.

To sum up: The changes imposed on the cultivation in Bihar by the appearance of synthetic indigo in 1897 have, during the past 20 years, greatly altered the general character of the soil and necessitated a fresh method of treatment. Planters have been deprived

of the financial aid which was formerly available to enable them to take leases of large parcels of land in which exchange was easily assured, either by the taking of first leases, the renewal of old leases after the lapse of some years, or by the budli or exchange of indigo lands with cultivators' lands. In place of these advantages they have had to ring the changes on the same land under a system leading to certain, and in many cases rapid, exhaustion. When lands have been let out to ryots, it has been to grow exhausting crops such as tobacco and chillies, and the soil returns to the planter in a very impoverished condition.

There are of course notable exceptions to the conditions depicted above. Thus planters frequently point out to me that certain fields have given good crops of indigo continuously year after year for an unlimited period. These fields are usually the sites of old villages and are of high fertility, mainly owing to the accumulation of human and animal excreta for generations. In these the process of exhaustion will naturally take far longer before they show a failure of crops. But such cases are the exception, not the rule.

Again, many planters have expressed to me their difficulty of understanding how soils which gave good indigo crops for a hundred years should quite suddenly show a rapid falling off such as followed the appearance of wilt in 1907. Actually this is the very behaviour which was to be expected. It is quite easy to understand that if a soil originally contains 100 parts of "available" phosphate and the crop removes one part each year, no marked falling off of crop will occur for 98 to 99 years, but that then quite suddenly the crop will fail to an increasing extent each year because it can no longer easily obtain the one part of phosphate corresponding with a full crop. It must be clearly understood that a *certain* amount of regeneration takes place each year in the soil owing to the liberation of *water-soluble phosphate* by the ordinary soil agencies (bacterial action, following cultivation or fallowing) acting on the insoluble mineral phosphates (in the analyses termed "total phosphate") always present in the soil. But the trouble at the present time is that the amount of this regeneration each season is not sufficient to give a full or even a good crop in the case of indigo. Moreover, this

regeneration takes place only in the *surface* layer of the soil where the soil agencies are most active. The soluble phosphate produced is rapidly used up by surface growing crops, and there is no opportunity for the small amount of soluble phosphate liberated to wash down into the lower layers of soil (where the Java plant mainly feeds) to renovate them. The consequence is that soils are frequently found which still give good or fair results with oats, barley or country crops, but fail more or less completely with indigo. One of the most striking instances of this kind may be cited—Byreah, Field No. 1* where the following analyses were obtained :—

Depth	Total P_2O_5	Available P_2O_5
0–6″	0·1371	0·00505
6″–12″	0·1273	0·00136
12″–36″	0·1049	0·00029

Here the amount of available phosphate in the *surface* layer is relatively very high for Bihar—not far short of the quantity generally regarded as necessary for good fertility in Europe (0·01 per cent.). But below 12″ the amount of available phosphate is extremely small (0·0002 per cent.). The behaviour of indigo grown in this land exactly corresponded with what would be expected from the analysis. The plant grew very well for 2 or 3 months, but when it reached a height of about one foot, growth was checked and large patches died out. The deep feeding roots of the Java indigo had reached a layer of soil in which there was no longer proper nutrition.

The complete revolution in the system of cultivation in Bihar, which followed the capture of the indigo market in 1897 by the synthetic dye, led to a far more drastic stripping of the soil. Under this new system the soils are now showing signs of rapid deterioration. If crops are to be maintained in the future, the method which has been adopted in all civilized countries—scientific manuring—must be introduced. Some 20 to 25 planters have expressed their willingness to make trials on their estates with superphosphate this season. The principal difficulty has been to obtain superphosphate, but it is hoped that in several cases at least supplies will be at hand before the rains cease, so that the effect can be seen on next year's crop.

* For full particulars and analyses see *Indigo Publication* No. 1, page 52.

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* For full particulars and analyses see *Indigo Publication* No. 1, page 52.

TABLE

Statement of produce from Java plant at various stages

Date	Particulars	Bighas cut	Acres cut	Green plant	Average plant per bigha	Indigo made per press of 20 srs.	Average per bigha	Average per acre
1918		B. C.		M. S.	M. S.	M. S.	S. C.	S. C.
June 17 ...	Kept fallow 12 months (1)	12 0	10·47	998 0	83 20	2 20	8 5	9 8
,, 18 ...	Superphosphate and sannai (2)	11 0	9·60	993 30	82 6	3 0	10 14	12 8
,, 19 ...	Jamoona Singh's *khuski* (3)	2 15	2·40	500 20	182 0	1 0	14 8	16 10
,, 22 ...	Manured with seet-water (4)	3 10	3·05	667 10	190 20	1 3	12 4	14 1
July 4 ...	Superphosphate and sannai (5)	4 12	4·01	614 0	133 20	3 0	26 1	29 14
,, 5 ...	Seet dug in with *kodali*	9 10	8·29	662 0	69 20	2 20	10 8	12 1
,, 6 ...	Seeted land, sown in February along with Sumatrana (6)	9 0	7·85	938 30	104 10	3 0	13 5	15 4
,, 7 ...	Seet dug in with *kodali*	15 0	13·09	1,103 0	73 20	3 20	9 5	10 11
,, 8 ...	Java of Bhoji Chaper mixed with February sowing	11 10	10·04	889 10	77 10	3 0	10 7	11 15
,, 9 ...	February sowing near Amla's Derakar-singh Tewary Toke	15 17	13·83	1,004 30	65 6	2 0	5 0	5 12
,, 10 ...	February sowing and Hiranda plant	14 0	12·22	954 20	68 7	3 0	8 9	9 13
	TOTAL ...	108 14	94·85	9,235 30	85 0	27 23	10 3	11 10

(1) This land is of better quality than
(2) Note the coldness of the water. The
(3) Java in this field grew to a tremendous
(4) Java in this field grew to a tremendous
(5) Height of crop 5 to 6 feet, *covered with*
(6) This Java was put down at the same

N.B.—There is a very big difference in the produce from 18th June to 4th July from the same sun from 27th June to 4th July.

I.

of mahai and from various qualities of land at Moniara Concern.

PRODUCE					Indigo made by cake measurement at 7 srs. per inch	AVERAGE PRODUCE						Temperature of water in khajana. °F.
per 1,000 c.ft. of vat		per 100 mds. green plant		Green plant per one maund indigo		per bigha		per acre		per 1,000 c.ft. of vat		per 100 mds. green plant		Green plant per one maund indigo	
S.	C.	S.	C.	M. S.	M. S.	S.	C.	S.	C.	S.	C.	S.	C.	M. S.	
13	14	10	0	399 0	2 28½	9	0	10	5	15	1	10	14	368 0	86
16	10	13	4	301 10	3 6	11	7	13	2	17	8	13	15	284 20	83
11	1	8	0	500 20	1 0½	14	10	16	12	11	3	8	0	497 15	88
8	5	6	8	612 0	1 5	12	13	14	12	9	6	6	11	593 0	86
25	0	19	8	203 20	3 9½	28	2	32	4	26	15	21	1	189 20	90
20	13	15	1	264 30	2 25	11	0	12	10	21	14	15	13	252 10	88
16	10	11	8	346 30	3 13	14	12	16	15	18	7	14	2	282 10	88
19	7	12	11	315 0	3 30½	10	0	11	7	20	14	13	10	293 0	88
16	10	13	7	296 10	3 13	11	9	13	3	18	7	14	15	267 10	88
11	2	7	15	502 10	2 7½	5		6	5	12	1	8	11	458 20	88
16	10	12	9	318 0	3 16½	9	12	11	2	19	0	14	4	279 20	89
16	2	11	15	334 30	29 34½	10	15	12	9	17	7	12	14	309 0	...

that treated with sannai and super.
day was also very cloudy and cold.
height, 8′ at the least and more wood than leaf.
height, 8′ at the least and more wood than leaf.
leaf from top to bottom.
time as Sumatrana, February and March.
field. This is attributable to very heavy rain in June, 15·60″, and there being a dry spell of hot

SOME OF THE PROBLEMS ARISING OUT OF THE SUCCESSFUL INTRODUCTION OF AMERICAN COTTON IN THE WESTERN PUNJAB.*

BY

W. ROBERTS, B. Sc.,

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THE introduction of American cotton in the Punjab by the Agricultural Department has brought out a number of problems, partly owing to the difficulties experienced by the Department in this work, and also on account of the success which has attended the work. In order to appreciate these difficulties it is necessary briefly to outline the outstanding features of the work. Work on American cotton started at Hissar in 1902 and at Lyallpur in 1903 and 1904. Previous to that there were some plants of American cotton to be found among the *desi* or country cotton grown, especially in Shahpur, Lahore and Jullundur. The very severe boll-worm attack of 1905 and the somewhat less severe attack in 1911 were found to affect American cotton to a very much less extent than country cotton. The experience of 1905, and especially of 1911, had a very marked effect on the attitude with which zemindars regarded American cotton. The policy of the Agricultural Department up to 1912 was to import seed from Dharwar every year though most of the zemindars growing this cotton kept their own seed. Experience in 1913 showed clearly that the sowing of seed acclimatized in the Punjab and plants of the rough-leaved type was the only safe policy to adopt. It had appeared for some years that imported seed was not very reliable as it contained so many different types. The Department in 1912 and 1913 put out two special

* A paper read at the Fifth Indian Science Congress, Lahore, 1918.

selections which had been handed over by the Economic Botanist in 1910 for trial at the Lyallpur farm. One of these, *viz.*, 4 F, proved to be a very safe plant and the area under it since 1913 is roughly as follows :—

1913	100 acres.	
1914	4,000 ,,	
1915	10,000 ,,	
1916	30,000 ,,	
1917	120,000 ,,	probably 140,000 acres.

The total areal under American cotton in 1917 was 274,000 acres, of which, as will be seen, over half was pure 4 F, and probably another quarter was impure 4 F from mixed seed obtained from ginning factories. The total area under American in 1911 was probably under 10,000 acres and reached 30,000 acres in 1913. It will be seen that since 1911 the increase has been rapid and phenomenal. The reason for the comparatively slow progress from 1903 to 1911 was mainly connected, in the first place, with the fact that the plant was not acclimatized, and, secondly, with the fact that the premium over *desi* cotton was at first only R. 1 to R. 1-6 per maund even in cotton sales and generally only a few annas per maund in the *mandi* or market. Previous to 1908 the cotton used to be sold by arrangement through the Agricultural Department at a premium of R. 1 to R. 1-8, but, owing to delays in recovering money and other difficulties connected with a monopoly, Mr. Milligan, who was then in charge of the work, started auction sales. The quantities at the latter were generally from 300 to 500 maunds and premiums up to R. 1-8 per maund were realized. Sales were temporarily dropped in 1911 and 1912, but were started again in 1913 by the writer both with a view to obtaining the seed of 4 F and to stimulate competition. By 1913 this cotton was becoming known in Bombay, and it was easy to get R. 1 to R. 1-4 premium in the ordinary market. At the sales the premium went up to Rs. 2-8 and Rs. 2-12. Since then the number of sales have increased rapidly until this year the Department will have sold in this way at fourteen sales over 100,000 maunds

[1] *The Agricultural Journal of India*, vol. X, pt. IV, 1915; vol. XI, pt. III, 1916; vol. XII, pt. III, 1917; vol. XIII, pt. I, 1918.

valued at roughly £130,000. Since 1914 all the cotton (*kapas*) coming to the sales is classified according to purity, and no American cotton with over 5 per cent. *desi* cotton admixture is sold at the auctions. Premiums averaging Rs. 4 per maund were obtained in 1916, and the highest price reached this year has been Rs. 21-15 per maund, when country cotton was selling at Rs. 15 per maund. Although the cotton sold through the Department sales is only about 10 per cent. of the whole, the value of these sales has been enormous both in attracting new buyers and in securing a wide and open market. This year four buying agencies representing Bombay and Ahmedabad mills have come forward as active buyers. Since 1915 Messrs. Tata & Sons, who were the first to come into the market from Bombay, have facilitated our task and helped to establish the market. Ordinary Punjab cotton which used to be grown exclusively in the Colonies is classified in Bombay as Sind-Punjab and fetches the lowest price in the market. Punjab-American is quoted since 1915-1916 at from Rs. 20 to Rs. 40 per candy (784 lb.) over Broach, or Rs. 100 to Rs. 150 or more above Punjab *desi*. This means Rs. 4 or Rs. 5 per maund of *kapas*, which is the premium this cotton is fetching at present. One of the conspicuous features with reference to the introduction of a new cotton in India is the slowness with which the trade responds to any change that takes place. This holds true for both superior and inferior varieties and consequently tends to put a premium on work with low grade high yielding cottons such as "Aligarh white" in the United Provinces and "Roseum" in the Central Provinces.

The difficulties encountered have been therefore as follows :—

(*a*) From 1903 to 1911 the problem was to get a fair premium. The cotton began to command premiums independently of sales in 1911, but this premium was far too low and generally only As. 8 to As. 12 instead of Rs. 2 or Rs. 3.

(*b*) With resumption of sales in 1913 premiums went up. The quantity had increased from 10,000 acres in 1911 to 30,000 in 1913. Since 1911 there has been no looking back.

(*c*) In spite of increase in area it was only by bringing in and encouraging outside bidders, *e.g.*, Tatas and Bombay and Ahmedabad mills that fair prices could be obtained. This was largely owing to the combination of the local ginning factories who in the Punjab buy cotton, and these resented the organization of the zemindars by the Agricultural Department and in many cases combined to wreck the sales. Attempts to eliminate abuses in "weighments," "arbitration," and "rejections" met with strong opposition, and factory owners in many places, *e.g.*, Lyallpur, have not bid at our auctions for two or three years. With the assistance of Mr. A. J. W. Kitchin, C.I.E., Deputy Commissioner of Lyallpur, the Department drew out a series of rules and conditions regarding "weighments," "allowances," and "arbitration" to remedy some of the above abuses and these have worked with conspicuous success. The cultivator is beginning to realize the advantages of "co-operative sale" and great developments in this direction may be expected in the future.

(*d*) In spite of assistance through auctions it had been noted that prices in outlying markets which were some distance from Lyallpur tended to be well below Lyallpur prices. To remedy this partially at any rate, it was decided to post up Lyallpur and Bombay prices daily at the chief markets. The idea is to keep zemindars informed of the real value of their produce and of the general trend of the market. There has been a marked effect already and in all outlying markets prices have advanced closer to Lyallpur prices. At Tandlianwala which is about 40 miles from Lyallpur by road and over 100 miles by rail, prices up to this year were sometimes as much as Rs. 2 per maund below Lyallpur prices, but in the present year have not been more than As. 6 per maund lower. The effect in the Lower Bari Doab has been

even more pronounced and has in consequence reacted very favourably on the growing popularity of cotton as a crop.

(*e*) Much of the American cotton produced in the Colonies was sent to Bombay mixed with *desi* cotton, the latter being put in to the extent of 10 to 25 per cent. and sometimes even more. This mixing was partly accidental owing to over-crowding in ginning factory compounds and also mainly deliberate. Zemindars grow these cottons pure nowadays, and it is rare to see a field of American with over 5 per cent. *desi*. It is easy to detect mixture in the *kapas* and zemindars are heavily penalized both in the Department's auctions and by factory owners for admixture of *desi* cotton; hence the rapid disappearance of mixtures in the field. When the cotton is ginned it is very difficult to detect even 10 per cent. mixture, and hence mixture in baled cotton is not uniformly or adequately penalized in Bombay. This practice must ultimately affect every one, even those who try to send American pure to Bombay. A remedy must be found up-country. Ultimately no doubt it will be necessary to license ginning factories and use this handle to penalize mixing. As a first step in remedying this and other evils, the Punjab Government have accepted certain suggestions of the writer regarding conditions under which any new factories can be built. Probably some sort of combination among factory owners in the form of an Association which could be recognized in Bombay is the only reliable and constructive manner of tackling this difficulty. Membership of this Association would involve responsibility and an undertaking to send cotton of definite purity. The penalty for breach of these conditions would have to be a heavy fine or loss of membership. Such an Association would command confidence in Bombay and

be to the interest of ginners themselves as well as that of zemindars.

(*f*) *Pure seed.* With concentration on one type, *viz.*, 4 F, the whole of the American cotton will in time become standardized. Already over half the American cotton grown here is of this variety, and the proportion will increase greatly in the next two or three years. The Department hopes to sell enough seed for 200,000 to 250,000 acres of this type in the coming season. The seed is sold at a premium of 40 per cent. and covers all expenses involved in premiums and in supervising ginning, etc. As the seed rate is only 8 lb. per acre the increased price of seed amounts to only As. 3 per acre and farmers gladly pay the necessary premium. It is possible that a better type than 4 F will be forthcoming. In the course of a few years it will certainly improve as selection is carried through. Owing to the existence of a number of large estates in the Colonies there will be no difficulty in keeping seed pure. A good deal of attention must be concentrated on this work as it will become of growing importance as time goes on.

(*g*) The greater the quantity of a good class of cotton which can be grown the easier it is to secure fair prices for the produce. So long as the quantity is small only a few buyers can secure the cotton, and competition is in consequence much restricted. With the extension of irrigation the area under American cotton will, of course, increase, but at present an area of 450,000 acres will represent the limit in sight. Cotton undoubtedly pays better than wheat in the Western Punjab, and, in the case of American cotton, farmers are beginning to realize that it is a very safe crop.* The great question of increasing summer

*See paper by the writer on this subject contributed to the Punjab Irrigation Congress, 1918.

supplies in the canals when the rivers are in flood is becoming therefore of even greater importance than formerly. This is a matter of very wide and deep significance to the future prosperity of the province. The foundation for the success of such a policy is being laid in the introduction of American cotton. Immense developments are possible in this respect in Sind also, where staple cotton of much finer quality than can be grown in the Punjab only awaits the advent of a secure irrigation system. Such development in Sind would react beneficially on the Punjab as it would tend to raise the price of Punjab-American.

THE CONSOLIDATION OF AGRICULTURAL HOLDINGS IN THE UNITED PROVINCES.

BY

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(Continued from page 230, vol. XIII, pt. II.)

PART II. OUTLINE OF PROPOSED CHANGES.

THE first part of this paper has been devoted to an exposition of the more important economic principles affecting the consolidation and enlargement of agricultural holdings and to defining and finding a solution in general terms of the problem of establishing permanently a higher standard of living. The practicability of attaining these objects has purposely been left unconsidered. It was intended only to obtain a clear view of the right goal to aim at; because such a clear view is necessary before the practical measures to be taken for the purpose of changing the present evil can even be discussed fruitfully. Also in order to obtain a simple and clear view of the object to be aimed at I purposely avoided details; and these may in some cases be filled in here.

CONSOLIDATION OF ALL OWNERS' HOLDINGS NECESSARY.

It is necessary to distinguish between the scattering of the strips of one *mahal*, or legally recognized unit of ownership, and the scattering of strips held by one cultivator, whether from one or more owners. For clearness of diction I use the term *unit of cultivation* to denote the whole of the fields actually cultivated by one man, or by a family or partners, as one business concern, whatever the ownership of fields may be. The cultivator may hold some of his

fields as a tenant with occupancy rights, and others as a tenant-at-will, and himself own yet other fields, thus making up a cultivating unit of, say, 10 or 12 acres. The scattering of strips in ownership* would not be a matter of vital concern were it not that it involves almost of necessity the scattering of the fields of a cultivating unit, because a tenant would experience very great difficulty in making the numerous agreements which would be needed to get a consolidated cultivating unit. I come, therefore, to the conclusion that the only practicable course is to adopt a policy of abolishing both scattered ownership and scattered tenants' holdings at the same time by consolidating the units of ownership.

In cases when the ownership is not at present scattered—that is to say, where a whole village, or a large part of a village, is held as one *mahal* by a 16-anna shareholder, or in imperfect partition—it would seem to be feasible for the owner, or the two or more shareholders, to agree to rearrange the holdings for letting purposes. One obstacle to this is the novelty of the idea, and the consequent opposition which would be raised even by tenants-at-will as a united body; and a further obstacle is the absence usually of any expert agent to carry out for the landlord the re-division of his land into the fresh holdings. The land needs to be re-surveyed, and new holdings graded in size according to the quality of the land, distance from the *abadi*, etc. The principal difficulty, however, is the occurrence of occupancy holdings with their fields thoroughly intermixed with the fields of tenants-at-will. The occupancy tenants cannot, under the present tenancy law of the Agra province, be bought out; and it is exceedingly difficult to arrange an exchange of fields which will be regarded by occupancy tenants as mutually satisfactory. Consequently nothing is done.

Advantages of consolidation admitted.

Yet scattered holdings are admitted to be a serious evil which is frustrating the progress of agriculture in several parts of India.

* Both *mahals*, and *pattis* thereof, are frequently composed of scattered fields in different parts of the village.

I take it to be generally agreed by agricultural experts that it is desirable in most places to consolidate scattered holdings more or less completely, the idea being that a holding should be compact, except where the nature of the country is such that the safest and most economic business is to carry on a mixed farming requiring river meadow lands, and plains or uplands in due proportion.

The disadvantages of the present condition of holdings and the advantages of re-stripping have been so well stated by many authorities that I need do no more than indicate my agreement with their statements. In 1912, Mr. Moreland, then Director of Land Records and Agriculture in the United Provinces, prepared a note for the United Provinces Government[1] which was printed and circulated by this Government. His proposals will be considered later on in this paper. In the same year Mr. G. Keatinge dealt briefly with this question in the Deccan.[2] In 1916, Mr. Burt read a paper before the Science Congress at Lucknow on "The Re-alignment of Agricultural Holdings";[3] and more recently a committee appointed by His Highness the Gaekwar of Baroda has fully investigated the question of the minute subdivision of holdings in that State.[4] Dr. Harold Mann has also called attention to the evils of excessive subdivision and cultivation of scattered fragments of land. He points out that cultivating a holding of small scattered fields has the great disadvantage of very small holdings in preventing the use of machinery and labour-saving appliances, whilst also "it has all the evils of large holdings, in that it prevents the adoption of really intensive cultivation by any holder."[5] In a subsequent publication he has amplified this study.[6] The importance of the

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[1] Dated 29th June, 1912, and enclosed under No. 19 I-505-1912 of 1915.

[2] *Rural Economy in the Bombay Deccan* (Longmans), pp. 40-2, 51-5.

[3] Reprinted in the *Agricultural Journal of India*. Special Indian Science Congress Number, 1916, p. 33.

[4] *Report on Consolidation of Small Scattered Holdings*; issued by Baroda State Printing Works. As. 10.

[5] "Economics of a Deccan Village." *Indian Journal of Economics*. vol. I. p. 420. Reprinted in the *Agricultural Journal of India*, July, 1917.

[6] *Land and Labour in a Deccan Village*; University of Bombay: Economics Series No. 1 (Oxford University Press), 1917—Chapter III: The Land and its Divisions and the Holdings.

question is being widely recognized in the Bombay Presidency and it has received attention in the Bombay Legislative Council on more than one occasion during the past two years.[1]

Scattered strips characteristic of primitive society in all countries.

The cultivation of scattered strips is a well known and very widely distributed economic phenomenon which seems to be characteristic of a certain stage of the evolution of primitive society in all races of mankind. The first three stages of the evolution of society are (1) families living by hunting and gathering wild fruits; (2) nomadic tribes living by pasturing domesticated animals, and gathering wild vegetable products; (3) "extensive" cultivation, as it is called by economists.[2] Nomadic tribes, having learnt to take occasional catch crops, gradually settled down and began to break up patches in the jungle. They had no rotation of crops, but broke up new patches in the waste as required.

The *abadi* is characteristic of the most primitive agricultural people. They settled in a definite spot for the village, and thus came a fourth stage. All the lands near the *abadi* became cultivated by the growing population of the village and the children of large families divided the home fields and had to make their cultivated area up to a size sufficient for maintenance by taking in fields from the waste. The fifth stage is the almost complete absorption of the cultivable waste, except what is needed for grazing land; and the sixth stage, the subdivision of holdings through the growth of population until the minimum economic size is reached, corresponding with a slightly improved cultivation which is forced on the people for maintenance. Here a stage of economic equilibrium is reached in which population must be stationary and the death-rate equal to birth-rate on the average, though owing to variations of the seasons,

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[1] Proceedings of the Bombay Legislative Council; especially the 14th and 15th March, 1916.

[2] Cunningham, W. *Growth of English Industry and Commerce during the Early and Middle Ages*, 5th ed., p. 33. *Cf.* Bucher. *Industrial Evolution*, Trans. Wicket (Holt & Co., N. Y.) pp. 45 *et seq.*

it is largely by famines and epidemic diseases that the average death-rate keeps the population down.

This is the last stage characteristic of primitive civilization, and society may remain in this condition for centuries. When advanced civilization begins to demand progress of the agricultural community, two lines of advance are possible: (1) by education and co-operation, and particularly by instruction of the people in the methods of intensive agriculture, so as to increase the productivity of the small scattered holdings, as has been done in France, Japan, Denmark and Ireland; (2) the other line of advance is to promote improved efficiency in agriculture by a re-arrangement and enlargement of holdings. The former method would appear to be very limited in its scope—in economic phraseology, the marginal productivity of additional effort devoted to improving the culture of small holdings declines rapidly. The only exceptions are in places where there is a particularly large demand for special crops, *e.g.*, the environs of Paris, London, or Calcutta.

For the production of the staple crops the economies of large scale production on compact holdings are so great that small holders of scattered fields can hardly make a living in competition, where the market is ruled by a considerable volume of production on a large scale. They are handicapped not only in labour, but by the difficulty of employing capital in the form of machinery and permanent improvements. This is well understood in England. It is easy, therefore, to establish two propositions: (1) that the progress of national economy, that is the welfare of the country as a whole, demands the cultivation of all staple crops on large holdings with abundant capital, because of the great economies, and therefore increase of wealth, which would thus be realized; and (2) that if large holdings become numerous in some parts of India, *i.e.*, Punjab, Central Provinces and parts of the United Provinces and Bengal, the system must rapidly (that is in 20 years or so) be extended throughout the whole of India, because the cultivation of staple crops on small holdings will become so unremunerative as to yield less profit than will support the existing standard of living.

Necessity for Government intervention.

It may be admitted that the economic welfare of India requires the introduction of the system of cultivation on large compact holdings, and yet be questioned whether there is need for Government intervention in the matter. It may be answered at once that it is highly probable that, were it not for the very great economic friction created by the primitive land tenure customs and laws, the change would have come about already. Unfortunately the effect of British legislation in India, which created occupancy tenures and permanent ryotwari and zemindari holdings, has been greatly to increase the difficulty of change; and it may be confidently asserted that the difficulty of re-arranging and enlarging holdings is now so great that the expectation of a profit three times greater than that which may be fairly anticipated would not be a sufficiently powerful economic force to bring about the change. It is, therefore, essential that the Government should intervene, and by means of special legislation facilitate the consolidation and enlargement of holdings.

The experience of other countries supplies ample precedent for the special intervention of Government to secure this end. In all countries the last stage of primitive tenure involves not only an intermixing of fields, but common rights in grazing on the pasture and waste, and, sometimes, on the stubble. Such rights have everywhere proved too complex and stubborn to be liquidated by agreement over any large area of country, and special legislation has proved necessary. The pioneer country in this special legislation was England; but many other countries have been obliged to undertake special legislation as noted above. As the change has been carried practically to completion in England it will be profitable to glance briefly at the methods which were adopted and the results obtained in that country.

The enclosure movement in England.

In England the consolidation and enlargement of holdings was nearly always accompanied by the erection of a ring fence about the new holding, which was usually partly carved out of the common land. Hence the process variously called re-stripping, re-alignment,

consolidation, redistribution, re-partition, or reorganization, was in England termed "enclosure." The type of cultivation, which was practically universal in England during the Middle Ages, is known as the "open field system." The lands of the manor (or village, as we should call it in India) were classified as follows: (1) the demesne close (or private compound and home fields of the lord of the manor); (2) arable fields; (3) meadow land, beside a stream or river; (4) common pasturage on which the villagers had limited grazing rights; (5) waste, with unlimited free grazing until later centuries when the growth of arable and pasture absorbed most of it; (6) forest, with well-defined rights of the villagers for taking fuel and timber. The villagers, whether free-holders, villeins in servile tenure, or tenants-at-will of the former or of the lord of the manor, cultivated a large number of strips scattered throughout the arable fields, the number of separate strips being from 4 or 5 up to 50, but the most frequent number was probably about 20. The standard size of strip was the acre, 220 yards (one furlong) in length and 22 yards wide; but half and quarter acre strips were not uncommon, besides irregular plots caused by the contour of the ground. The acre was supposed to be the area which one plough with four, six or even eight oxen, could plough in a day, and as no cultivator owned as many oxen as were supposed to be required for the plough, a co-operative system of assistance prevailed. Whilst the demesne (equivalent to *sir*) lay partly in enclosed home fields, the larger part of it was in scattered strips in the open fields. The arrangement of the strips in the arable fields is well shown in a map published by Mr. F. Seebohm in his book "The English Village Community."[1] The best description of the English field system prior to the enclosures is to be found in a recent book by Professor H. L. Gray of the Harvard University.[2] He reproduces a number of maps of old parishes showing clearly the arrangement of the strips in the arable fields and the manner in

[1] See frontispiece and plate opposite page 26. The latter plate is also reproduced by Cunningham, *ibid.*, page 44. I have relied considerably on Cunningham's account of the mediæval system of agriculture and would refer readers particularly to pp. 73-8 and pp. 526-34. An elementary sketch of the manorial system is contained in Gibbin's *Industrial History of England* (Methuen), pp. 5-22.

[2] *English Field System* (Harvard University Press), 1915.

which enclosures usually began to be made around the village dwellings which were concentrated in one place along one or two roads. Other sporadic enclosures of the meadow land were made for pasturage purposes, the initiative being usually taken by the lord of the manor enclosing part of the demesne.

The manner of cultivation differed in various parts of England and changed slightly in the course of centuries. The more primitive method was known as the "two-field system," and it involved letting the land lie fallow every alternate year. The arable strips of the village were grouped in two open fields, perhaps 200 acres or more each. In one year all the cultivators were obliged to leave all the strips in one of the fields fallow because the cattle were turned out to graze on the fallow land, and so the whole of their cultivation was done in the strips of the other field. Next year the fields were changed. A gain of cultivating an additional one-sixth of the total area was made by adopting a three-course rotation which involved the arable lands of the village being laid out in three fields, and was termed the "three-field system." Each field was laid fallow in succession so that each of the three fields was put through the following rotation :—

(1) Ploughed and sown with wheat in October, reaped the following August ; grazing on stubble during autumn.

(2) Ploughed in March and sown with barley, oats, beans or pulse ; grazing on the stubble during the autumn.

(3) Land ploughed twice, but lying fallow, and open to cattle.

The three-field system seems to have gradually superseded the two-field system except in certain districts where the latter remained until both the systems gave way before the modern method of convertible husbandry in which periods of grass growing alternated with arable culture. It was the profit of sheep farming and cattle breeding which first led to the withdrawal of lands from the common cultivation and their enclosure with fences. This movement began in the east of England in the fifteenth century and resulted in a considerable depopulation of certain parts of the eastern counties. The incentive of sheep breeding did not extend over the rest of the

country, and probably also there were greater legal difficulties in making enclosures in other parts of England, a larger percentage of land having been freehold originally in the eastern counties. Sporadic enclosures took place throughout the sixteenth century, but it was not until proper ideas of convertible husbandry and drainage were learnt from the Dutch in the seventeenth century that a widespread interest in the consolidation of holdings and their enclosure began to be evinced.

The best account of the enclosure movement is given by Professor Gonner in his book "Common Land and Enclosure" (Macmillan, 1912). He has traced from contemporary documents the whole course of the movement and has described the legal methods adopted at various times to carry out the enclosures. In the seventeenth century, the enclosures were mainly carried out by agreements of the owners, which would mean the lord of the manor, the copyholders and one or two free-holders. It was usually considered necessary to render the agreement indefeasible by obtaining a decree of the Court of Chancery. A few extracts from Gonner's book will be of interest.

"During the seventeenth century, agreements were even more important. The testimony as to their prevalence is strong and spread throughout the period. They find mention in the record of the action of the Privy Council, between 1630 and 1640, which illustrate the difficulties which beset those anxious to agree, and also the methods whereby a reluctant consent was often wrung from those who were unwilling. Again, in the controversy which raged a little later as to the effect of the enclosures in the Midlands, and particularly in Leicester, we are told of the lords of the manors and others anxious to enclose that if they cannot persuade, they commence a suit in law." [1]

The difficulty of this method was that "the decree would not affect rights which were claimed by others than the parties to the case..... It may be suggested that it was the recognition of this limitation which led to the disuse of this particular method. Its

[1] *Ibid.*, pp. 53-4.

inability to procure anything like a binding or universal consent, together with the difficulty attending purely voluntary, and even registered agreements, led to the open and steady demand for powers to prevent obstruction which could be obtained only by application to Parliament." [1]

"This new stage on which enclosure enters under parliamentary authority admits of division into three periods. During the first, which extends through the eighteenth century to the general act of 1801, the growth of the private acts may be traced from the very rudimentary form of the earlier acts to that high degree of development where, by reason of the very uniformity and complexity of the provisions included on each occasion, a general act was rendered not only feasible and useful but essential. The second period is from 1801 to 1842-5[2] and includes the private acts which were passed in accordance with the provisions of the general act. After 1845 the powers hitherto exercised directly by Parliament, and through commissioners specially appointed by act, were delegated to different permanent bodies established by act, and subject to Parliamentary control, inasmuch as their decisions or orders had to remain on the table of the Houses before becoming operative." [3]

The usual procedure in making enclosures by private act was, at the close of the eighteenth century, when the technique had fully developed, as follows.[4] Proceedings were commenced by a petition for an act, which involved considerable expense whether the act was ultimately obtained or not, and this placed the initiative in the power of wealthy owners only. A meeting of owners and others known to be interested had to be called and a preliminary agreement of all those who could be got to agree to submit their interests to commissioners sanctioned by Parliament was included in the petition. In most cases the commissioners, usually three in number, were named in the petition or draft bill. The commissioners were usually paid. Probably the best "were practical men with knowledge of

[1] *Ibid.*, pp. 55-6.
[2] That is, to the general act of 1845.
[3] *Ibid.*, pp. 59-60.
[4] This is abstracted from Gonner, *ibid.*, Book I, Chap. III.

farming and surveying, who gained experience from being employed in enclosure after enclosure."[1] The powers of the commissioners were considerable and each was bound by oath to administer with justice. Their award was final, except as to the title to property. The local proceedings were arranged with a view to publicity, and usually opened with a public meeting to consider the draft petition. After such negotiations and meetings as proved necessary, signatures of the draft bill were obtained and witnessed, showing the degree of dissent, if any; and the act was then usually passed by Parliament with little or no alteration, if in the usual form.

The commissioners being now appointed called a public meeting at the locality, at which they usually took the opportunity of obtaining public consent, or at least hearing objections, in regard to the surveyors and valuers they proposed to appoint. The survey and valuation, the latter parcel by parcel for every holding, were then made. Besides fertility of the soil, drainage, situation and cost of enclosing were always taken into account. The proposed allotment of new fields was then made, and a revaluation of the land on this basis. Upon the improvement of value thus ascertained was first assessed the cost of the enclosure; and then the rights of tithe, various rights of the lord of the manor, and of the forest ranger, etc., were compromised. The commissioners then proceeded to lay out the village anew, apportioning land of amount corresponding in the proportion of new total value with the proportion of estimated value of the previous rights of each recipient. "The new enclosures were as a rule regular and compact.... They lay, in the case of some, at a considerable distance from the little village of farm houses, while others had the advantage of having their holdings conveniently near."[2] One of the most important duties imposed on the commissioners was the laying out of roads, which were to be planned before the land was distributed. The public roads were to be constructed at the common charge of the enclosure. Private roads for access to holdings were planned by the commissioners and the expense apportioned by agreement amongst those whose holdings they served.

[1] *Ibid.*, p. 75.

[2] *Ibid.*, pp. 82-3.

"There is no doubt that the roadmaking performed under the enclosure acts co-operated with the increase in and improvement of roads under the Turnpike acts [1] in effecting the great change in the means of locomotion which marks the end of the eighteenth century." Fencing or hedging of the holdings was required to be done, and this bore heavily on the owners of small allotments, so that they frequently had to sell their rights to large holders.

The expenses of enclosure were heavy and caused loud complaints by the smaller owners. The Board of Agriculture has calculated that the average area affected by the acts was 1,162 acres each; and that the average expenses were as follows :—

	£
In obtaining the act	497
Survey and valuation...	259
Fees of commissioners and pay of clerks, etc.	344
Fences	550
	1,650

This amounts to an average of £1 8*s*. 1*d*. (or Rs. 21-1) per acre; but apparently it does not include the assessed cost of roads. The appreciation of value was considerably more than this for the larger holdings; but hardly equal to the expense for the smallest of the new holdings.

The subsequent history of the new compact holdings is one of gradual consolidation and enlargement. Immediately the redistribution was effected and the land fenced, many cottagers and small holders found themselves possessing a field of 5 to 10 acres, or two fields aggregating 15 or 20 acres. They failed to make them pay, got into debt and sold their holdings, usually to the lord of the manor, who threw such additional fields into his compact farms on

[1] "Turnpike Trusts originated in the desire to maintain and improve roads. In many cases, however, they are directed to the provision of new roads (see pp. 1851, xlviii; County Report, Kent). While the first act was in the seventeenth century, such acts are scarce till Anne, and not really plentiful till towards the end of G. II., thenceforward they are very numerous. The trusts were usually for limited periods, but these were open to renewal. By the beginning of the eighteenth century, the length of road under Turnpike Trusts was about 17,000 miles (in 1818, 17,601, Parl. Papers 1818, xvi.; in 1821, 17,329, Parl. Papers. 1821, iv.), of course the majority of roads were not under such trusts, other roads being given in 1818 at 86,116 miles."

which he was proceeding to build farm houses and buildings. For the first few years after enclosure all the cultivators, except the farmer of the old demesne, probably continued to live in the village and go daily to their new fields. But with the gradual formation of larger farms, involving a considerable household working at one centre, there was a movement to secure a residence on the holding itself, and as fast as landlords could find capital for building farm houses the exodus from the village high streets took place. It is important to notice that holdings of less than about 40 acres in area were generally located as near the village site as possible. With the formation of larger farms many of the objections to isolated residence disappeared because there was usually a larger family and several relatives and hired labourers living on the farmstead. These numbers gave increased security, and a sufficient degree of social intercourse, if supplemented by visits once or twice a week to the village or market town. During the first three-quarters of the nineteenth century the movement for increasing the size of farms seems to have continued in England, two or three small farms of fifty to one hundred acres being thrown together and let as one. One of the farm houses and appurtenant holdings would be greatly enlarged, and those of the other holdings be dismantled, or be let as residences with garden and paddock if anywhere near a town.

It is worth noting that a vast improvement in the intelligence and class of youths who remain to work on farms in England has occurred during the past 15 years by the cheapening of the bicycle whereby they can meet daily in the evening in the village. It is not difficult to imagine how, in rural India, social life would be raised to an altogether higher plane, were the holdings to be sufficiently enlarged and methods of cultivation improved so that the majority of villagers could afford to own bicycles, and if inter-village roads were all metalled so that they could use them. The Indian villager is fond enough of gadding about if he gets the opportunity; and it is difficult to overestimate the educational value of local as well as distant travel. Nothing would more rapidly diffuse an interest in and knowledge of improved methods of cultivation.

Mr. Moreland's Note.

In his note referred to above, Mr. Moreland first indicates the advantages which would accrue from a re-distribution of holdings; and then rightly points out that the present waste of power becomes more serious as the cost of production increases. He regards it as desirable that experiments should be made in villages where conditions are favourable, and proceeds to outline a method of proceeding by arranging exchanges of fields. He then suggests that if it were "found possible to make the bulk of the holdings in a village fairly compact," the question of moving homesteads out would arise. "Where the holding is at a long distance from the village, the cultivator might decide after discussion to build a house on it." He next refers to the necessity of retaining the uneconomic holding (in due proportion) as a ladder by which the best and thriftiest labourers can mount to the rank of cultivator. The next paragraph is important: if the result of experiments as above indicated should be negative, the question would then arise of passing an Enclosure Act giving landholders the power to override the opposition of a minority and reorganize their villages with a clear course open. Finally he deals with the question of increasing the size of holdings.

The criticism of this last section of the note relating to the size of holdings must depend entirely on the critic's premises. Mr. Moreland writes as if looking at the question from what I hope I may call the old-fashioned point of view. The question with him is whether external economic forces will force attention to the size of holdings as a serious social evil through the margin between price and cost of production becoming less than a subsistence minimum. He thinks there is no reason for immediate anxiety, and hails the co-operative movement, especially co-operative purchasing and marketing, as a means of at least staving off, if it cannot permanently prevent, such a calamity.

Objects of proposed changes.

My own object in the proposals which I shall make in the remainder of this paper is a very different one from that which may be inferred from Mr. Moreland's note; and I would submit that it

is of fundamental importance to have clearly in view the object of any proposed measures before judging them, and that it is always necessary to decide definitely upon the aim of any reform under consideration before proceeding to discuss what changes are needed and how they are to be carried into effect.

In the measures which I shall now tentatively outline I keep constantly in view as their object the deliberate and progressive increase of the welfare of the Indian people.

The economist is directly concerned with two ways of realizing this end :—

(1) By the development of the economic resources of India with the utmost rapidity consistent with safety in assuring permanence of the results obtained.

(2) By the provision of the physical basis for progress to a higher standard of life—intellectual, religious, moral, and social—by indicating—

(*a*) how to utilize for this purpose with the greatest efficiency the wealth produced by the development of resources ;

(*b*) how the material environment, as regards dwellings, towns, roads, water-supply, public works, and so forth, may be arranged so as to react with the greatest effect in the desired direction of intellectual, moral and social uplift.

There can be no question but that the right line of advance in developing the resources of India is to utilize the machinery of Government in order so to rearrange the land tenure system as to enable the existing body of skill and knowledge of the agricultural art possessed by the cultivators through tradition and by numerous trained experts, and the existing supply of capital in both private and State control, to be employed with the maximum of efficiency in the production of wealth. At the same time in devising measures to this end care should be taken that there is not a serious loss of character and other beneficial qualities of the agricultural population by the social revolution that must be caused, but rather that the measures taken for the production of wealth tend at the same time

to the upbuilding of the more perfect man. As a step in this direction I proceed now to define the type of rural community which appears to me to be a realizable ideal for the near future, and a very distinct advance along the road which I have indicated.

I would like to say at the outset that my views on this question were only formed after a visit last year to the Lower Chenab and Lower Bari Doab canal colonies. I very much doubt whether any one who is not familiar with the wonderful canal colonies of the Punjab will have the faith that has been born in me as to the possibility of the rural regeneration of the rest of British India. In the remainder of this paper I shall refer only to temporarily settled tracts where zemindari system of landlord and tenant prevails as in the provinces of Agra and Oudh, the Central Provinces and parts of the Punjab. Much that I say will also be applicable to the permanently settled territories of the United Provinces, Bihar, and Bengal.

(To be continued.)

BLAST OF PADDY.

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In Papanasam Taluk of Tanjore District in the Madras Presidency there was a marked shortage of this year's second crop of the variety of paddy (*Oryza sativa*) called Korangu Samba. The cultivators attributed the short crop to unwonted rain at the end of December when the plants were in flower, but this is an afterthought remembered at harvest-time to explain the shortness.

As an example of how small the crop has been in particular fields the information got in the village of Umaiyālpūram is interesting. Last year as a second-crop paddy Korangu Samba gave 1,008 Madras measures* per acre. This year one acre gave 720 M.m., of which 96 M.m. remained after winnowing. Another field of 1⅓ acres gave 192 M.m., of which 20 remained after winnowing. *i.e.*, 15 M.m. per acre.

A ten-cent plot in a badly infected field in the village of Umbalapadi was harvested and winnowed in my presence. The yield consisted of 3¾ M.m. weighing 308 tolas (almost 8 lb.), *i.e.*, at the rate of 37½ M.m. per acre. The owner said that the usual yield in a ten-cent plot on this land was 120 M.m. and the Tahsildar told me that the average for the taluk was 72 M.m. Before I arrived, most of the paddy had been harvested, and of what still remained on the ground this field was by far the worst I saw. Accordingly, though this experiment shows how great the loss can be, yet from it no estimate can legitimately be made of the loss over any large area and such an estimate I had no means of making, though figures

* One Madras measure contains 108 cubic inches, and one M.m. of paddy weighs 2½ lb.

given me by the Tahsildar from the village officers' reports show that over an area of 1,687 acres in twelve villages the average yield of Korangu Samba was 216 M.m. per acre. In these villages, too, about 428 acres of this variety were sown as first crop, three-quarters of which were in two villages. The yield varied from 36 to 720 M.m. per acre, the average being about 264 M.m. This shows that there was considerable shortage in the first crop this year. Outside these villages there does not seem to have been much talk of short crop and the variety is said not to be widely grown in the taluk as a second-crop paddy.

Perhaps one can get a more impressive idea of the loss caused if it be given in money value on the basis of 12 M.m. to the rupee which was the price after harvest in February. In the two examples from the village of Umaiyālpūram given above, the shortage is $1,008 - 96 = 912$, and $1,008 - 15 = 993$ M.m. respectively, or Rs. 76 and Rs. 82 per acre. In the field from which the ten-cent plot was chosen the shortage is $1,200 - 37\frac{1}{2} = 1,162\frac{1}{2}$ M.m., or Rs. 97 per acre. For the 1,685 acres the loss is $1,008 - 216 = 792$ M.m., or Rs. 60 per acre, while over the whole area it is 1,336,104 M.m., or Rs. 1,11,000. This is a very great loss indeed and bears out Metcalf's[1] expression that "from the standpoint of the amount of loss it causes it undoubtedly ranks with the grain rusts as one of the most serious plant diseases of the world."

According to the villagers, Korangu Samba was first tried as second-crop paddy in Ganapathi Agrahāram and was brought in 1915 from a village about 25 miles south, where it was grown as a single-crop paddy. The 1915-16 crop in the new conditions was a very good one. Being well spoken of it was tried on a larger scale next year and the crop was again good, being 960 to 1,680 M.m. per acre. This year, however, it has caused much disappointment. To some other villages it was introduced in 1916 from a village where also it was grown as a single-crop paddy. The first year's crop was a heavy one but this year it is very poor. Both these places of origin are outside the irrigated part of the Cauvery delta and the

[1] Metcalf, H., on pp. 99-105 of *The Diseases of Tropical Plants*, by M. T. Cook, 1913.

soils are higher and more freely drained. This would naturally lead to a deeper rooting habit in the plant and this may account for the high yields which this variety gave in the first one of two crops after being introduced to the heavy soil conditions of the delta lands, though the variety seems not to have been able to adapt itself permanently to those conditions after it had lost its initial vigour. Several people have declared that they will not grow this variety again. There is little likelihood of its being used in these villages and a note of warning has been given to ryots generally in the delta to avoid this variety in future on double-crop land.

Characters of the disease.

Small spots appear on the leaves and extend through the tissues of the leaf, appearing equally on both upper and lower surfaces. Reddish or brownish at first, the centre soon becomes pale yellow. The spots extend more rapidly in the longitudinal direction and may become one inch long by one-fourth inch broad. By this time the edge of the spot becomes pale brown, and ultimately the whole area of the spot becomes brown. Adjacent spots coalesce. The brown areas sometimes extend along nearly the whole of one side of the leaf-blade or they may extend across it and the leaf gradually withers. The central part of the spot assumes a soiled, smoky appearance owing to the presence of the sporophores and spores in abundance, and this occurs on both surfaces of the leaf. Spots are found on the leaf-sheath as well as on the leaf-blade, and may also involve the ligule. When a spot is present at the junction of the blade and the sheath this part often becomes very dark brown. When that part of the leaf-sheath immediately outside a node is infected the stem below it is sometimes infected too, becoming almost black at the node and for a short distance above or below it or both. The stem sometimes bends over at this infected node. When the leaf that encloses the ear-head is infected some of the lumes touching the spots become dark brown and the region of the stem below the ear-head becomes brown and ultimately almost black for a distance of about one inch. This discoloration also extends upwards into the lowest branches of the ear-head. Not

infrequently the stem collapses and breaks at this place and the ear-head hangs downwards. Apart from a few dark brown glumes the ear-heads usually look quite normal, yet the ears are seldom filled. They either have no rice-grains or very stunted grains though some of them may be filled normally. From the ten-cent plot in a badly-infected field in the village of Umaiyālpūram mentioned above, the grains of fifty ear-heads that had a dark discoloration on the stalk just below the ear-head but that looked otherwise normal were counted. There were 7,275 paddy-grains, of which 171 were full and these were found on nine ear-heads, *i.e.*, 2·3 per cent. of the grains contained rice-grains. Of the others a remnant of a rice-grain was present in each paddy-grain, but it was of no use as rice. In many cases, the people had no suspicion that the plants were abnormal and they expected a good yield. It was only when the coolies, paid in kind for their first day's work, complained that they got no rice from the paddy that the owners realized that their crop was short.

A considerable number of plants appear to have been attacked while in quite a young stage. The earliest formed leaves were covered with spots and were dried up as also were most of the later formed leaves. The plants were only about one foot high. They had very few stems with ear-heads and even these contained only empty grains. In other plants the main tillers had matured and there was a considerable amount of secondary growth of branches from them. The ear-heads of the latter showed arrested development and in many cases their branches were not expanded, but had remained together as they were in the stage when they protruded from the sheath. The ears very seldom contained rice-grains. These young branches as they were in all stages of development showed well the various stages of the attack. When a young branch had been attacked early, *i.e.*, before the ear-head had come out of its sheathing leaf, the leaves had numerous spots and were dried up and the ears were empty. The empty ear-heads stand erect and are conspicuous in the field when the normally matured ear-heads all bend over with the weight of the grain. When a branch had been attacked later, the spots occupied a small proportion of the leaf-surface and the ear-heads were comparatively well

illed, though some contained stunted half-formed rice-grains. On he other hand, some plants lightly attacked had well-filled ears. Thus a plant attacked in an early stage suffers worst while one ttacked at a late stage of its development is but slightly affected.

In the early stage of the attack these characters are usually airly definite, but as the general health of the plant becomes affected nd it loses its green colour, the colouring of the diseased part ecomes indistinct and the presence of the fungus is not easily ecognized on the blackened, faded and discoloured leaves and tems which become invaded by various saprophytic fungi.

The characters of the disease found on Korangu Samba were lso seen to a small extent on Kārun Kuruvai, Chinna Sirumani, ellai Sirumani, Thōga Samba and Tanga Samba though not on illai Samba, but there is no complaint of short crop on any of hese. Two plants of Chinna Sirumani were found in the field from hich the ten-cent plot was chosen but they did not have the isease.

The fungus *Piricularia oryzæ* was found on the spots on all ositions in which they were found on the plant, *viz.*, leaf, node, tem, ear-head and glumes, and in all the varieties noted. Its yphæ penetrated the cells of the various tissues and were found n abundance. The sporophores protruded in groups of two to ur from the stomata and nearly every stoma on a spot had its uota. The spores were formed singly at the end of the sporophore. hen one spore is shed the sporophore grows a little and produces nother and five may be produced in all, though in culture 17 have een formed on one sporophore. When looked at through a lens he surface of the spot appeared to be covered with a brown delicate etwork, which consisted of sporophores and spores. The spore s pale yellow and pear-shaped, and at the broad end is a slight rotuberance that attached it to the sporophore. Each spore has wo cross walls dividing it into three cells. They germinate readily n water. Two hours after immersion they begin to germinate, and in ighteen hours have produced long branching hyphæ sometimes with pherical resting spores with slightly thickened walls and dense rotoplasmic contents. Metcalf says that the three-celled spores

rarely survive over three months, but that the resting spores may survive at least twenty months. There is thus ample opportunity for the fungus to live over the dry weather and infect the next crop.

The fungus has been declared to be the cause of Brusone in Italy by Cavara and Farnetti, of rice-blast in the United States of America by Metcalf and Foulton, and of Imotsi in Japan by Kawakami. In these countries it has done a very great deal of damage.

Seeing that paddy as it is grown is not adaptable to ordinary preventive measures like spraying, any method of control of the disease will have to be along cultural and selective lines. There seems to be a consensus of opinion among those who have investigated the disease that nitrogenous fertilizers render varieties of paddy more susceptible to the disease and this will have to be studied under the local conditions in Tanjore. The success that has attended the production of resistant varieties in other countries, especially Italy, is encouraging, if the disease becomes a menace to paddy cultivation in this country.

EXHIBITS OF THE GOVERNMENT AGRICULTURAL CHEMIST, MADRAS, AT THE MADRAS INDUSTRIAL EXHIBITION, DECEMBER, 1917.

BY

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A CIRCULAR was received from the Director of Agriculture, Madras, on 15th August, 1917, stating that an industrial exhibition would be held at Madras during Christmas, the main object of which was to encourage the manufacture in this country of articles hitherto imported, and the Government Agricultural Chemist was specially asked "to make endeavours to show articles of food prepared from local agricultural produce which could replace similar imported articles." The ordinary departmental work was at once stopped and the whole of the staff turned their energies on to this problem.

So far as food products were concerned, it was felt that the primary problem was the production of a good malt and malt extract, as these are important constituents of many patent foods. The scope of the work was extended so as to include other substances than foodstuffs and the articles finally prepared for the exhibition may be classified as follows:—

A. Infant and invalid foods.
B. Breakfast and other foods.
C. Flours and starches.
D. Beverages.
E. Casein and casein products.
F. Miscellaneous.

A. Infant and invalid foods.

The search for a grain of good malting capacity. Malted foods claimed first attention in the laboratory. As barley, which is the cereal grain almost universally used as the base for the preparation of different malted foods, is grown only to a small extent in Madras, a substitute for barley was sought for amongst the important cereal grains of the Presidency, *viz.*, paddy (*Oryza sativa*), *cholam* (*Sorghum vulgare*), *ragi* (*Eleusine coracana*), *cumbu* (spiked millet) and *tenai* (*Setaria italica*).* These grains were each malted and their diastatic activity determined and compared; the experiments showed that *cholam* and *ragi* malted as well as barley. The malting process was carried out in the following manner:—

A quantity of each kind of grain was soaked in water for 24 hours, drained and spread in large tin trays to germinate, the trays being covered with a wet cloth to preserve a moist atmosphere. After three to five days when the radicles were prominently visible and had attained a length of about $\frac{1}{2}$ inch, germination was arrested by first drying in the shade for two days on the stone floor of the verandahs and then in the sun for one day, after which the malted grain was ground in a laboratory sampling mill.

The diastatic activity of each malted meal was determined as follows:—

Fifteen grams of the malt were digested with 250 c.c. of water at room temperature (average 28°C.) for four hours. The extract was filtered, the first portions being rejected. One c.c. of the filtrate was added to 15 c.c. of a 2 per cent. solution of soluble starch, and, at the end of one hour, the starch solution was tested with iodine. In the case of *cholam* and *ragi* no starch remained, but in the case of others starch was present and had not been

* According to the Agricultural Statistics of the Madras Presidency for 1916-17, the normal acreages of the above crops were:—

	Acres
Paddy	10,687,950
Cholam	5,407,450
Ragi	2,502,350
Cumbu	3,509,120
Barley	3,120

completely hydrolysed even after twelve hours, thereby indicating that *cholam* and *ragi* malted better than paddy, *cumbu*, maize, or *tenai*. Preliminary experiments showed that *cholam* and *ragi* were a little superior to barley in diastatic activity as shown by colour reactions with iodine. Further investigations regarding the differences in diastatic activity of barley, *cholam* and *ragi* and of the sugars formed by hydrolysis therefrom have been carried out and submitted for publication as a memoir in the chemical series.[1]

The malted *cholam* and *ragi* thus prepared were utilized for the preparation of several types of patent foods.

Benger's food type. The coarsely ground *cholam* and *ragi* malts were sieved in a 100-mesh sieve to remove husk, mixed separately with arrowroot starch in the proportion of 3 to 1 and bottled air-tight. Thus were obtained two substitutes for Benger's food, one from *cholam* and another from *ragi*. The prepared foods had the same properties as Benger's and, when prepared according to the directions given on the Benger's food bottle, were found to have all their starch hydrolysed.

Malt extract. Four hundred grams of *cholam* and *ragi* malts were each extracted with 1,200 c.c. of water at room temperature for three hours, filtered through muslin, clarified with kaolin and filtered, and the liquor evaporated *in vacuo* at a temperature of 40–50°C. and at a pressure of about 50 m.m. so as to prevent the destruction of the diastase. While the evaporation of the diastatic liquor was proceeding, the residue on the muslin was transferred to a large flask with water and quickly raised to boiling, whereby the starch became gelatinized and the proteids coagulated. This gelatinized starch solution was filtered through a percolator and added gradually to the evaporating malt liquor, so that hydrolysis of starch took place simultaneously with the evaporation of the liquid. As soon as the contents of the distilling flask became sufficiently thick which usually took from 12 to 15 hours in the improvised apparatus, the malt extract was poured out into stoppered bottles. The

[1] Memoir vol. V, no. 4 of the Chemical Series, by B. Viswanath, T. Lakshmana Rao and P. A. Raghunathaswami Ayyangar (*In the press.*)

specific gravity of the extract thus obtained was 1·30 and, in order to imitate the colour and the caramel odour of the imported article, baked starch was added in some cases during the evaporation process. Malt extracts prepared from both *cholam* and *ragi* have kept well for over six months.

Mellin's food type. To the diastatic liquor referred to in the preceding paragraph, gelatinized starch solution was added in the proportion of 1 of malt liquor to 2 of starch solution and the whole evaporated *in vacuo*. The residue was dried *in vacuo* and then powdered with some lactose, forming a satisfactory substitute for Mellin's food.

Horlick's malted milk type. Partially skimmed milk containing 1 per cent. of fat was evaporated and dried *in vacuo* at 50°C. The dry residue was powdered, mixed with desiccated malt extract (*i.e.*, Mellin's food) and sodium bicarbonate in the proportion of 69 : 30 : 1 and quickly bottled.

Sanatogen, Plasmon, and Eucasein types. Casein being the chief proteid material in milk and possessing good keeping qualities, if carefully prepared and stored dry, several patent foods have been prepared from casein and placed from time to time on the market under different trade names, *viz.*, Lactarine, Guttman's nutrient milk powder, Sanatogen, Eulactol, Eucasein, Plasmon, Dr. Reigl's milk albumen, etc. Carefully prepared dry casein is tasteless and odourless, somewhat resembling flour and is easily assimilable. The processes of manufacture of several of these different patent foods are not known with certainty and the methods detailed here merely represent attempts made by the staff to prepare some of them.

For the above foods, casein was precipitated from skimmed milk containing very little fat by curdling with sulphuric acid and purified by squeezing the whey, redissolving the curd in slight excess of ammonia and reprecipitating with slight excess of acetic acid. The purified casein was well washed with water, passed through a screw-press to remove water, dried at 70°C., ground to a powder and bottled.

A substitute for Sanatogen was obtained by dissolving the casein in sodium glycerophosphate, evaporating the viscous mass

to dryness *in vacuo* and reducing the dried mass to powder. The product is soluble in water.

A substitute for Eucasein was prepared by passing ammonia through casein suspended in alcohol and afterwards separating and drying the casein. This ammoniated casein is soluble in water.

A substitute for Plasmon was made by mixing together 80 parts of casein containing about 5 per cent. of fat, 7 parts of sodium bicarbonate and 13 parts of lactose. It is partly soluble in water.

These three casein food products prepared in the laboratory were found to resemble the respective patent foods in colour, solubility and taste.

Nutrose. Groundnut cake is a rich nitrogenous material containing 45 to 50 per cent. of proteids, and is used in the country either as cattle food or as manure. With slight manipulation, it can be converted into a suitable human food and this has already been done in the highly advertised German food Nutrose.[1] Proteids are made up of a number of amino-compounds but the proteids of groundnut cake are deficient in one of them, tryptophane. This is rectified by the addition of dried milk, casein or wheat flour.

Good, well-pressed groundnut cake obtained from the Deputy Director of Agriculture, IV Circle, was ground and 94 parts of the meal mixed with 5 parts of casein and 1 part of sodium bicarbonate, the resulting product being similar to Nutrose. Nutrose is a valuable invalid food, chiefly for diabetic patients of whom there are only too many in India.

If 3 parts of wheat flour are mixed with 1 part of Nutrose, the resulting flour can be made into excellent bread, much superior in nutritive quality and taste to pure wheaten bread.

B. Breakfast and other foods.

Cheese. Good samples of cheese of the Cheddar kind were prepared successfully, notwithstanding climatic difficulties, by two methods (1) by the addition of rennet, and (2) by sour milk. The

[1] *The Agricultural Journal of India*, vol. XIII, part II, April, 1918, pp. 351–355.

cheeses were highly appreciated at the exhibition and pronounced to be excellent.

Grape nuts. An attempt was made to reproduce this highly appreciated American food in the following manner. A hundred parts of *cholum* or *ragi* malt were added to 400 parts of wheat flour, and water was added so as to produce a mass of a thick consistency. This was left for four hours so that as much wheat as possible might be digested by the malt. Three hundred parts more of malt were then added and the whole worked into a dough, together with some yeast, kept an hour to ferment and baked in a hot-air oven at 200°C. for about an hour. The baked bread was next cut into thin slices, dried in the draught oven, coarsely pestled in a mortar and sieved to proper grains.

Shredded wheat. Flour milled from well-husked wheat was cooked in steam for two hours. After cooling, a mixture of tartaric acid and sodium bicarbonate, in the proportion of 4 : 6 to 100 of wheat flour, was prepared and the mass was pressed through a die in a screwpress and the issuing shreds collected and rolled gently to resemble the imported article and then baked in the oven until dry and crisp.

Vermicelli and macaroni. Fine wheat rolong was mixed with sufficient water and kneaded into a dough which was then passed through improvised dies in the screwpress. The shreds of vermicelli and the tubular macaroni issuing from the dies were dried in the shade and packed.

Desiccated coconuts. Desiccated coconut is finding increasing application in the preparation of confectionery, sweets, etc., and a number of large factories are run in America for desiccating coconuts. Coconuts are plentiful in this country and the principle of manufacture of desiccated nut is quite simple. Coconuts of medium ripeness were scraped in the household coconut-scraper, spread in thin layers in a draught oven, dried and secured in air-tight bottles, the preserved coconut forming a crisp material. This was much appreciated at the exhibition.

Candied peel. Healthy skins of oranges and lemons, with their inner placenta removed, were boiled in water until they became

soft and the water was drained off. Concentrated thick syrup of cane sugar was prepared and the boiled orange and lemon skins were suspended in the same until they became translucent. The peel was then removed, dried and once again treated with boiling syrup of proper consistency, and stirred until the candied peel nearly set, after which it was stored in bottles.

C. Flours and starches.

Soup flours. Pea flour is the one ordinarily used for making soup for European tastes. As peas are only grown to a small extent in the Presidency, whereas several pulse grains are grown in very large areas throughout the country, an attempt was made to prepare soup flours from these pulses as substitutes for pea flour. Healthy grains of red gram or *dholl* (*Cajanus indicus*), Bengal gram (*Cicer arietinum*) and green gram (*Phaseolus mungo*) were dried in the sun and soaked in water, the lighter grains were scooped out and the soaked grains dried and husked in light stone mills. After winnowing, the clean kernels were ground into flour in a heavy country stone mill, sieved through a fine mesh sieve, dried in the steam oven and put in bottles. The flours have kept well for over six months and have been pronounced, after actual use in cooking on a number of occasions, to be as good as pea flour for making soup.

Starches. Pure white starches are in very great demand in the country, chiefly for textile fabrics. *Cholam*, *ragi* and sweet potatoes were manipulated in the following manner for making starches :—

Cholam and *ragi* grains were separately soaked in 0·3 per cent. caustic soda for 24 hours, washed free from alkali, dried in the sun and ground into flour. The flour was now soaked in 0·15 per cent. caustic soda for another 24 hours, the supernatant liquid was siphoned off and the starches were well washed until free from alkali, and the fine starch granules were separated by sedimentation, dried in the sun and stored.

In the case of sweet potatoes, well-washed tubers were scraped on the surface to remove the brown thin skin, ground in a mortar

to a soft pulp and mixed with water. The starch granules were separated by sedimentation and dried.

All the three starches were fairly pure and analysed as follows :

Samples	Pure starch	Moisture at 100°C.
Starch from cholam	84·92	8·79
,, ragi	84·79	10·63
,, sweet potatoes	85·20	9·69

D. Beverages.

Lime juice cordial. The juice of lime fruits was clarified with kaolin, sweetened and sterilized. This refreshing drink has kept well for six months without undergoing fermentation.

Cholam beer. Four thousand grams of malted *cholam* were ground into a meal, mixed with 15 litres of water, to which 5 grams of $CaSO_4$ were added and the whole was maintained at 65° to 70°C. with continuous stirring for three hours, by which time it was found, by testing with iodine, that all the starch had been hydrolysed. The liquid was quickly raised to the boiling point at which it was kept for an hour, 20 grams of tannin and 100 grams of bitter gourd powder having previously been added. To some of the samples 2 oz. of hops were added. The mash liquor was filtered, cooled quickly in running water, diluted to a specific gravity of 1·050 and transferred to glazed pots such as are used in the pot culture house. Baker's yeast was added to a small quantity of the mash liquor to start fermentation and this was added, after six hours, to the liquid, in the pot. The rate of fermentation was tested by specific gravity which gradually went down to 1·025 in 24 hours and then remained stationary. The liquid was poured into beer bottles and corked secure. There was no attempt made at pasteurization for want of suitable apparatus. The beer was tolerably good for a first attempt.

E. Casein and casein products.

Casein. Skim milk (cows' or buffaloes') from a cream separator was used for the preparation of casein. While the coagulation of milk can be effected by several methods, *e.g.*, by the addition of

sulphuric acid, rennet or sour milk, precipitation by sulphuric acid was found most convenient and was effected by mixing 1½ parts by volume of strong sulphuric acid with 7 parts of water and adding the mixture to 1,000 volumes of milk. The precipitated casein was washed and dried and formed the base for the manufacture of a number of products.

Casein paints and distempers. Casein dissolves in solutions of the hydroxides of alkali and alkaline earth metals, being less soluble in the latter. The casein-lime compound, however, has the power of absorbing carbonic acid from the air and becoming insoluble, and it is this property which is utilized in the making of casein paints and distempers. These consist of mixtures of casein and slaked lime with suitable pigments. On the addition of water, the casein and lime combine to form a sticky soluble product holding the pigment in suspension. When spread as a thin layer with a brush on any surface—wall, timber or iron—it absorbs carbonic acid from the air becoming an insoluble durable coating which holds within itself the particles of the pigment. When applied to walls, the paint enters into combination with the underlying plaster and becomes increasingly durable.

The proportions of lime to casein and of the lime-casein to the pigment in the mixture are important. Too little lime makes the product insoluble, especially if exposed during storage, and too much lime induces the paint to come off in flakes. Similarly if too little paint be added, the coating is brittle and liable to flake off, and if too much, the paint will dust off and not stand washing. Again, it is only those pigments which are not affected by lime that are suitable for the manufacture of casein paints. These are, for example :—

whiting, zinc oxide and China clay	.. *for white*
ochre, chrome yellow, etc.	.. *for yellow*
raw and burnt sienna and umber	.. *for brown*
soot and carbon blacks ..	.. *for black*
red lead	.. *for red*
ultramarine	.. *for blue*
green earth, lime green, etc.	.. *for green*
and so on	

The recipes for the different paints are slightly different. White paint may be made up of casein 100, slaked lime 100, levigated chalk 800, borax 1 and ultramarine 2 to 3 parts by weight, while the coloured paints may be made from casein 100, slaked lime 100, levigated chalk 400, pigment 400 and borax 1 part. It is important that the ingredients are very finely powdered and thoroughly dried: when stored in tightly closed boxes lined with paper, the mixtures keep indefinitely without losing their properties.

For use, 50 parts of water are added to 100 parts of the powder in a clean vessel and stirred until the mass is homogeneous and free from lumps. The contents are then covered with a thin layer of water and set aside for 45 minutes, after which they are stirred with more water to the consistency of an oil paint. Thus prepared, it should be used without delay as it is liable to set hard in a comparatively short time becoming unfit in twelve hours. Rough surfaces must be painted thinner than smooth ones. As mentioned above, the paint will adhere to any clean surface, such as lime, plaster of Paris, cement, plaster, brick, timber, stone or metal, as well as canvas. It dries quickly with a matte surface and, after 36 to 48 hours, can be washed without fear and will stand the weather. So long as old coatings of lime on walls are removed and the substratum is firm, the casein paints will readily adhere and will not crack or peel off. A glossy paint for indoor use can be produced by spraying the painted surface with a mixture of turpentine and wax and polishing it afterwards.

Casein adhesives. Casein, in solution with caustic alkalis or alkaline salts, has adhesive properties and, as such, has been applied for the preparation of glues and cements which have been placed in the market under various trade names, such as casein-glue, cold glue, caseo-gum, etc. These are suitable for several industrial purposes, especially in wood work, as they are ready for immediate use without previous soaking and heating as with ordinary glue.

For wood, China and glass, 15 to 20 parts of casein are mixed intimately with 1 to 4 parts of borax and sufficient water added with careful stirring, when required for use.

Casein dissolved in a strong solution of borax forms a good, clear adhesive, keeps indefinitely and can replace gum arabic or dextrine. Caustic soda or potash or ammonia could be used instead of borax in making this liquid glue and the addition of a little carbolic acid or thymol prevents any chance of putrefaction.

Casein film.—Casein was tried as a substitute for gelatine in the preparation of photographic paper with good results. Writing paper of good quality was coated with a solution prepared as follows :—

Seventy grams of casein were heated with one litre of water to 50°C., 100 c.c. of a 25 per cent. solution of citric acid added and the mixture stirred until a homogeneous solution was obtained. Twenty grams of glycerine were then added.

The paper which was coated with the above was, after drying in the shade, drawn through a 5 per cent. solution of ammonium chloride to render the casein insoluble, dried and sensitized in the dark room by floating in a 10 per cent. solution of silver nitrate, and again dried in the dark room. Prints were obtained as on ordinary P. O. P., and the operations of toning and fixing were the same as with P. O. P. Several photographs printed on Government lined paper were exhibited.

Shoe and boot polishes. After several trials, the following recipes were found successful :—

Brown polish.—Dissolve 1 part of borax in 20 parts of water. Add 5 parts of shellac and warm until dissolved. Add 1½ parts of soap and 2 parts of casein and stir over the water bath until a homogeneous paste is obtained. Now add 2 parts of hard paraffin and incorporate with the paste, and then add gradually, with constant stirring, 30 to 40 parts of turpentine, thinning down with more water as may be found necessary. Finally add enough annato extract to give the required shade of colour.

Black polish.—Dissolve 2 parts of casein in 40 parts of vinegar, add 2 parts of paraffin and heat on the water bath, stirring the while until a pasty mass is obtained. Next add 50 parts of turpentine gradually and stir on the water bath to a uniform paste, adding water as may be necessary, and then incorporate sufficient lamp black into it.

A few drops of nitrobenzene are also added at the end to give a agreeable smell.

F. Miscellaneous.

Lactose or milk sugar. The whey draining from the curd i cheese-making was acidulated with acetic acid and heated on th water bath. The precipitated milk albumen was removed b straining and the evaporation was continued on the water bat until the liquid began to turn brown, after which the concentratio was continued *in vacuo* until a syrup was obtained. This wa poured in porcelain dishes and allowed to crystallize. Whe crystallization was complete, the mother liquor was drained off an the crystals were washed with a fine spray of water from which an the mother liquor a second and then a third crop of crystals wer similarly obtained. The different crops of crystals were separatel redissolved in water, shaken with bone charcoal and filtered. Th resulting clear filtrate was concentrated *in vacuo*. In the absenc of a centrifugal machine, the final separation of lactose was effected by the addition of alcohol and filtering. From the first crop o crystals a white product was obtained while the other two gav brown coloured crystals of lactose.

Citric acid. Limejuice clarified with kaolin was tested fo acidity and the calculated quantity of powdered calcium carbonate added to the boiling juice whereby the calcium citrate was precipitated. The precipitate was washed with boiling water by decantation and the calculated quantity of sulphuric acid (1 of acid diluted with 3 of water) added to the boiling solution, when calcium sulphate was precipitated and the citric acid went into solution. The sulphate was filtered off and the filtrate was evaporated and allowed to crystallize. The crystals were drained from the mother liquor, dissolved again in water, evaporated *in vacuo* and allowed to crystallize. A portion of the crystals was recrystallized by dissolving in water and allowing the water to evaporate slowly at a low temperature.

Tartaric acid. Full grown tamarind pods—not ripe fruits—were crushed in a mortar to a pulp, soaked in water, filtered over

a cloth, boiled with kaolin and filtered under the pump until a clear filtrate was obtained. This was tested for acidity, the calculated quantity of calcium carbonate was added to convert the acid into calcium tartrate and the calculated quantity of sulphuric acid (diluted 1 to 3) then added to the boiling solution, when calcium sulphate was thrown out as a precipitate and filtered off and free tartaric acid left in the filtrate. This was evaporated at a low temperature and allowed to crystallize. The crystals were separated from the mother liquor, redissolved in water and evaporated *in vacuo* and allowed to crystallize.

The two acids, citric and tartaric, prepared as above, are commercial products and cannot be said to be absolutely pure. It is proposed to estimate their exact composition later on.

Papain. Papain is a digestive enzyme acting on the proteids of food and converting them into soluble peptones. In this respect it resembles the pepsin of the gastric juice, but is superior to it in that the latter can act only in an acid medium, while the former can act in acid, alkaline or neutral solutions. The ferment can be easily obtained from the juice of the papaya fruit. Half-ripe papaya fruits, as they stand on the tree, are pricked with a small knife when a milky fluid exudes which soon coagulates to a plastic mass. A fair quantity is thus collected from a number of fruits, the fruits themselves not being spoiled in any way, and then extracted repeatedly with water in which the papain is soluble. The liquid is filtered, evaporated at 50°C. *in vacuo*, and the residue is again dissolved in the smallest quantity of water. The enzyme is now precipitated by the addition of alcohol, filtered, dried at a temperature of 40°C., powdered and stored in bottles.

Conclusion.

The Acting Agricultural Chemist and the staff attended the exhibition wherein the Chemist's stall attracted a great deal of attention from all classes of visitors and a number of samples of the exhibits were distributed.

It was a source of satisfaction to the staff that the Chemist's section was awarded one of the few gold medals presented by the

exhibition and also two Diplomas of Excellence—one for "Food Products" and the other for the work of the section in general. While the work done so far in the laboratory at Coimbatore indicates that great possibilities exist for the manufacture of suitable substitutes for articles now imported out of indigenous produce, it has to be borne in mind that the investigations are far from complete and require more concentrated application than possible in the laboratory of an agricultural chemist, wherein a certain amount of routine work on soils and manures has to be got through every year. The commercial possibilities of the manufacture of the above articles cannot be discussed at this stage until actual trials have been made on a larger scale and the investigations are more complete.

LUCERNE: WHY AN IRRIGATED CROP?

BY

MAJOR J. MATSON,

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I

ALL the writers on lucerne in this country speak of it as a crop which can only be grown by the aid of irrigation. Certainly in the more arid districts it is impossible to grow it without, but we are told that lucerne is successfully grown in America, unirrigated, in districts having a much smaller rainfall than the averages of the United Provinces and much of Eastern Punjab. Further, of all plants it is, or should be, suited to maintain itself alive in periods of drought, in view of its deep-rooted character.

Lucerne is such a valuable fodder that if it can be grown on unirrigated land, a valuable addition to the stock-carrying capacity of the country will be obtained.

II

Accordingly, trials were decided on, and in the autumn of 1915 a plot, measuring 4·6 acres, was selected on the Cawnpore Government Dairy Farm. The soil is a free-working loam of good quality and fairly well drained; it had been trenched in with bazaar sweepings twelve inches deep in about 1904, but in 1915 the only trace of the trenching was a thin black line about ten inches below the surface.

The plot was in grass, cut annually for hay, until 1914, and was then sown to *jowar* (*A. Sorghum*) in the summer, and barley in the winter; in 1915, sown to *jowar* in the summer, and in the winter to oats in which 8 lb. of lucerne seed was mixed.

When the oats were cut, lucerne plants were found thinly dotted about. These seemed healthy and strong, and it was decided to put the plot down to lucerne alone the following autumn. In preparation for this, the land was ploughed five times during the summer, a remarkable thing being that the scattered lucerne plants above mentioned were not killed in the process, although iron ploughs were used. No doubt a few died, but the bulk survived.

During the rains it was frequently cultivated to keep down the weeds, and sown on 29th September at the rate of 18 lb. per acre. A very good take resulted, and the crop grew well. Cutting began on the 28th of December and continued daily for issue to the stock, the rate of cutting being regulated by the pace at which the cut plants grew again, so as to have a continuous issue. This continuous cutting was kept up until the 10th of June, 1917, when the total production amounted to 95,014 lb. green lucerne, or 20,655 lb. per acre. At this time the growth had slackened, though it had not entirely ceased.

After the first monsoon rainfall, another cutting was soon ready and removed from 4th July onwards. The fifth cutting was taken in August, and a sixth was ready early in October, but this was made into hay and is not included in the recorded weights. The actual quantity of green lucerne cut in the twelve months from the date of sowing was 149,130 lb., or 32,421 lb. per acre. It was estimated that, with the October cutting made into hay, which was ready within twelve months from the first *cutting*, the outturn of green lucerne, per acre, was about 39,000 lb.

After each cutting the land was harrowed, the first time very lightly, but increasing in depth after each cutting until at the fourth time the harrows were run two to three inches deep. Seven-tine spring-toothed harrows were used and they kept the land thoroughly clean.

The outturn is less good than it might have been, had not "dodder" appeared in two or three patches in April 1917. We were advised to plough up the whole field, but by *cheeling* (scraping) the patches we were able to get rid of the pest, and then, in the autumn, resowed them.

In the winter and spring of 1917-18 the plant grew practically as well as in the year before, but the measures adopted to eradicate "dodder" reduced the outturn.

In both years the land was given a light dressing of rotted cattle manure, which no doubt helped the plants to some extent; but the important point is the ability of lucerne to establish itself and grow during eight months of practically rainless weather. This it has done now for two years in succession, or three years if the light seeding of 1915 is counted.

The rainfall, outside the monsoon season, has been as follows:—

1st October,	1916,	to 1st June,	1917 ..	7·04 inches.
1st ,,	1917,	to 1st ,,	1918 ..	4·84 ,,

As the results at Cawnpore, however, were likely to have been aided by the moisture-retaining properties of the old trenching in of bazaar rubbish, it was decided to make a concurrent trial on land having characteristics exceptionally unfavourable to conservation of moisture.

At Karnal a plot was prepared on the edge of a ravine, one of the poorest pieces of soil on the whole farm and exceptionally dry. This was sown in the autumn of 1916 also. The seed germinated well and in April of this year (1918) the plants were still alive and healthy, but the rate of growth has been slow throughout. This plot is in the middle of a grazing field and the cattle have grazed the lucerne with the grass, so no record of outturn has been kept. The only object was to discover if lucerne would remain alive under such conditions and this it has done. It should be stated, however, that the seed in this case was not ordinary Indian lucerne but a variety obtained from the United States called "Montana Dry Land Alfalfa."

Still another trial has been made since at Ambala, a plot of about one acre being sown down in the autumn of 1917. It was cut three times in the following winter and spring, and a fourth crop was kept for seed and harvested in June.

The rainfall at Ambala from 1st October, 1917, to 1st June, 1918, was 10·83 inches.

III

The trials, and our observations during their progress, go to show that unirrigated lucerne can be established successfully on most soils of the Gangetic plain, and that where there is sufficient moisture in the subsoil it will give a highly remunerative outturn throughout the winter and early summer, if the soil is of good quality and well drained.

The outturn will not, however, be quite as much as would be obtained from the same land under irrigation; on the other hand, the percentage of dry matter in the green lucerne is believed to be substantially higher when the plant is grown naturally than when forced by irrigation in a heated atmosphere.

The Cawnpore plant was not very high at any time, but the Ambala specimen was fully up to what would be called a good crop on irrigated land.

The rate of growth between cuttings was clearly and increasingly slower than it would have been under irrigation as the summer advanced, but it was steady and continuous till well on in June at both stations, which is very remarkable.

Another point to notice is that the unirrigated lucerne withstands the monsoon much better than the irrigated, and grows as naturally as at any other time. All the writer's experience of irrigated lucerne is that it gets sickly and practically stops growing in the rains. The reason no doubt is that the irrigated soil is already saturated underneath when the rains come and lucerne cannot withstand the consequent water-logging.

The general result of the trials appears to have a wider application than the military farms.

Two main limitations on the productive capacity of the average cultivated holding are—

(*a*) shortage of cultivating power—in other words, lack of fodder for cattle;

(*b*) lack of soil moisture.

With irrigation allowed on, say, one-third of his total area, the cultivator cannot be expected to devote irrigated land to any but "money" crops.

On the unirrigated land, he can spare a very small area for fodder crops in the *kharif* (monsoon cropping), and he has a certain amount of stalks and straw as by-products both then and in the *rabi* (winter cropping), but the total is far too little.

Advice to grow special fodder crops, such as berseem, for instance, which must be irrigated copiously, naturally finds him unresponsive.

As to *barani* fodder crops, in winter the soil moisture is never sufficient to give a heavy yield, and though a man may be driven to sacrificing a patch of his wheat to tide over a month of scarcity, he is fully alive to its wastefulness and the loss of money he incurs.

Lastly, as we know, the fodders usually produced, *jowar* stalks, *bhusa* and the like, are most innutritious, and if they are to do more than just keep cattle alive must be supplemented by oilcake, etc., at substantial expense.

If therefore we can find a crop which—

(*a*) need not be irrigated,

(*b*) will grow at that season of the year (January to June) when fodder is scarcest,

(*c*) has high food value itself and hence requires little, if any, supplement in the form of concentrates,

(*d*) produces a greater total weight in twelve months than other fodder crops,

(*e*) once sown stands for two or more years, and so saves renewed preparation of the soil and purchase of seed,

a substantial economy must result from its use.

If, in addition, the crop is one which need not displace any other but rather takes the place of the fallow, and this I think can be claimed for lucerne in most cases, there is a clear gain in the total productive capacity of a given area.

It is not suggested that there is anything new about lucerne but it seems possible that we have overlooked its greatest value, namely,

ability to obtain moisture in situations where no other fodder plant can.

The success of the trial at Cawnpore was mainly due to the very thorough and painstaking work of Mr. B. J. Newman, then Manager of the Government Dairy Farm there. The whole idea was as much his as the writer's.

THE TRUE SPHERE OF CENTRAL CO-OPERATIVE BANKS.

BY

N. K. KELKAR,

Governor of the Co-operative Federation, Central Provinces and Berar.

"If the foot shall say Because I am not the hand
"I am not of the body; is it therefore not of the body?"

THE July (1918) issue of the *Agricultural Journal of India* (vol. XIII, pt. III) contains an article from the pen of Mr. R. B. Ewbank on "The True Sphere of Central Co-operative Banks." It is stated that in the last few years there has been a distinct tendency, most marked in the Central Provinces, the United Provinces, and Bihar and Orissa, to make the District Central Bank the pivot of co-operative administration. The arguments are based mainly on theoretical grounds but reference is made to the practice adopted in the United Provinces, and it is implied that the practice adopted in those provinces is typical of the system adopted in the other provinces mentioned. A very copious extract is given from Mr. Willoughby's last (1916-17) Administration Report for the United Provinces. As I shall have occasion to refer to this extract it will bear quoting again at length.

"The system to which we are committed in this province entrusts the finance, supervision and indeed the whole fortune of the movement to the District and Central Banks. These banks are administered by Boards of Directors who are predominately urban and professional. Such bodies are by their constitution ill-adapted to establish the intimate contact required for the fostering and training of such a delicate plant as the young village credit society, or even for its control or finance when adult. The lawyer, banker,

and other professional gentlemen can hardly be expected to find time constantly to visit villages, often distant, and to find out what their staff is doing there. They are inevitably dependent on their paid staff. Now no committee of townsfolk can lend money with advantage or safety to a multitude of individual rustics whom they have never seen and never met and whose credit they cannot gauge through a staff whom they cannot check or control. The attempt is apt to result in the mere substitution of the urban middle class for the village money-lender as the usurer without advantage to either lender or borrower. For with an uncontrolled staff the effective rate of interest really paid tends to be quite as high as the bania's. . . . . Experience has continued to show that too many central societies regard their primaries rather as customers to be bled than as children to be fed."

It is noticeable that if this indictment of the system of control by Central Banks is accepted at its face value it would prove very much more than Mr. Ewbank would accept. For it would indicate not only that Central Banks are incapable of undertaking the audit, training, organization, etc., of primary societies, but also that Central Banks are incapable of performing with safety to their shareholders and with advantage to their primary societies those financial functions which Mr. Ewbank claims to be their sole *raison d'etre*. Indeed no system of Central Banks which "cannot lend money with advantage or safety to individual rustics whom they have never seen and never met and whose credit they cannot gauge through a staff whom they cannot check or control," would be a safe foundation on which to base that organization of central finance which Mr. Ewbank deems to be most desirable. It is worth while therefore to consider whether the system described by Mr. Ewbank is the system which is in force in those other provinces to which he alludes. So far as the Central Provinces are concerned it may be at once stated that the Central Bank is not the pivot of co-operative administration, and that neither control of audit, training, organization or propaganda is entrusted to it. The pivot of co-operative administration in the Central Provinces is the Co-operative

Federation which consists of all co-operative institutions in the Central Provinces voicing their opinion in the Federation Congress by representatives duly elected on democratic principles. Audit is under the control of the Registrar though the staff is partly paid from Federation funds, but the training, organization and propaganda are under the control of the Federation acting through its local representatives.

There is no little confusion in the use of the term Central Bank as applied to the controlling agency and it seems desirable to understand clearly what is meant when reference is made to control by a Central Bank. The Central Bank is a body corporate. It can advance money because as a body corporate it can hold property. Its Directorate may even pass resolutions on questions of policy. But when we speak of control and supervision of primary societies by a Central Bank we are really guilty of a terminological inexactitude. Primary societies can be supervised and controlled only by individuals. It is quite impossible to think of a Central Bank or even the Directorate of the Central Bank inspecting societies. The question that we must decide therefore is whether in the Central Provinces the Co-operative Federation should entrust the fulfilment of its resolutions to individuals, who are also either members or Directors of the Central Bank.

In his article Mr. Ewbank gives a description of the functions of the Central Bank but nowhere lays down either what its constitution is or what it should be. There is a brief reference of a line or two to the representation of primary societies on the Central Bank Directorate but the subject is not pursued. But clearly the constitution of the Central Bank is of the utmost importance in deciding the relation it should bear to its primary societies, and a discussion of this matter is therefore essential to the proper appreciation of the problem. There are three types of Central Banks. The first type sprang into existence when the necessity for affording financial facilities to the primary societies first made itself felt. The function of this type was, as Mr. Ewbank says, to advance loans to primary societies; it consisted of a small body of individual members having no financial stake in the primary societies who

put up the share capital necessary for the commencement of the business. It is in this sense that the term Central Bank is understood both in Mr. Willoughby's report and Mr. Ewbank's article, and it is against the interference in the affairs of primary societies by the Directors of Central Banks of this type that Mr. Ewbank's warnings are directed. And no doubt what Mr. Ewbank says has very great force in it. For it is obvious that unless the shareholders in a Central Bank are imbued with the true co-operative spirit and unless they are enthusiastic and their higher ideals are aroused, there is a very great danger of interference with the primary societies in the interest of what is commonly known as dividend-hunting. We have had our experience of this type of Central Bank in the Central Provinces, but our experience has been more fortunate than appears to have been the case of the United Provinces. Our Directorates were originally formed of Malguzars, richer agriculturists, pleaders and a small sprinkling of money-lenders. But we have always been able to secure on the Directorate men whose enthusiasm has been aroused and whose work has been disinterested and truly co-operative, and it is to such men that in the commencement the Co-operative Federation entrusted the execution of the policy laid down by it. Our lawyers have found time to visit village societies; in fact in several Central Banks the prominent pleaders have spent every civil court holiday throughout the year on tours of this sort. Our Secretaries of Central Banks have made a point of seeing and discussing village affairs with the societies when they come to Central Banks to take their loans, and even in the first stage of Central Banks it would be incorrect to say that the Board of Directors had been out of touch with primary societies or out of sympathy with their demands and requirements. At the same time so long as there is a possibility of a clash of interests between the individual shareholders of the Central Bank and the primary societies, it cannot be held that the organization is truly co-operative, and it is for this reason that we have advanced in the Central Provinces to the second form of constitution of Central Banks.

In the second stage the societies, having by this time acquired sufficient reserve funds or accumulated profits, are in a position to

ake up shares in Central Banks. Inasmuch as the number of ocieties in these provinces is larger than the individual shareholders he societies have acquired a controlling interest in the banks and he majority of the Directors of the Central Bank are elected from mongst their own members by the primary societies and Circle Unions ffiliated to the bank. The primary societies have thus a controlling oice in all questions of policy in the bank (subject of course to the resolutions not conflicting with the resolutions of the Co-operative Federation by which so long as they continue members of the Federation all are bound), and any attempt at selfish interference in the affairs of the societies in the interests of the individual shareholders of the bank would be very quickly suppressed. For it is not true, as some people believe, that the agriculturists are dumb, voiceless individuals. On the contrary, when their interests are concerned they are quick with their suggestions and slow to accept interference even by the more educated shareholders. The third type of Central Banks I need not discuss. It is an ideal to which ve hope to attain, when the primary societies' reserves are sufficient o take over the shares now held by individual shareholders both n Central and Provincial Banks. The accomplishment of this will take time, but when we shall have accomplished this we shall ave the co-operative movement owned and controlled entirely oy primary societies and their representatives.

It will now be apparent that the duties and functions which an be entrusted to the Directors of Central Banks must vary at he different stages of the movement. The functions of a Central Bank, *qua* Bank, are, in Mr. Ewbank's words, to say "yes" or "no" to loan applications, and in so far as a Central Bank approximates in type to an ordinary joint stock bank, in so far as the first consideration is the interest of the shareholders and not the interest of the societies, to that extent it is unsafe to allow the Directors of the Central Bank any part in the education or general supervision of the movement. But when the Central Bank is not merely a bank but a co-operative institution, when the interests of the Central Bank and its constituent societies are one, it is desirable, indeed it is necessary, that the members and Directors of the Central

Bank should take their proper place in the co-operative sphere, and it would be as illogical to exclude such Directors from supervising or training the constituent societies, either themselves or through the Federation staff placed under their control by the Federation, as it would be to expect the members of the *panchayat* (managing council) of the primary society to abstain from supervising or training the individual members.

Accepting the principle that the ideal to be aimed at is a system of societies and banks owned by the agriculturists themselves, that is to say, owned by the primary societies—and few would deny that this is the ideal at which co-operation aims—it is difficult to see how as the movement progresses it is possible to avoid entrusting training, organization and propaganda work to Directors and members of Central Banks. Mr. Ewbank states that in Bombay training and supervision are entrusted to guaranteeing Unions and in places where there are no Unions to local co-operators and chairmen of first rate societies. In the Central Provinces also training and supervision are entrusted to guaranteeing Unions and to representatives of primary societies sitting on Circle Union Committees. But the difference is that Circle Unions are members of the Central Bank, and chairmen of first rate societies and local co-operators of any eminence are without exception either members or Directors of the Central Bank. In fact as agriculturists accumulate profits and become themselves their own capitalists, it is inevitable that those individual shareholders in the Central Bank not otherwise connected with co-operation and out of sympathy with it should be gradually replaced by representatives of the primary societies; as this change occurs it becomes impossible and undesirable to disassociate the members of the Central Bank from controlling and regulating the primary societies, for those members are merely representatives of the societies and their control is not an outside control by persons whose interests are conflicting with those of the movement but inside control by the properly educated and more enlightened co-operators themselves.

Now, as regards the control of staff, we have always made a distinction between the banking staff as such which is paid for out

of the profits of the Central Banks and engaged in verifying the material assets owned by borrowing societies and looking after their trustworthiness in the interests of the shareholders, and the Federation staff which is paid for not by the Central Banks but by the Federation out of its own funds and which in addition to training and sometimes organizing societies visits each society at stated intervals and writes up its accounts. I should explain here that owing to the backwardness of education in the Central Provinces very few out of the several thousand societies comprise members sufficiently literate to write their own accounts. The primary societies have always been taught to regard the members of this travelling Federation staff as their servants and not the agents of the Central Banks. It has been impressed on them that the pay of this staff is provided by their own contributions to the Federation, and the few irregularities which have occurred on the part of the staff had been brought to light with surprising rapidity by the primary societies. The local control of this staff is entrusted frequently, though not necessarily, to the Honorary Secretary of the Central Bank, and this appears to have given rise to the idea that the whole control of primary societies is centred in the bank. But it should be remembered that the control of this staff is entrusted by the Governor of the Federation to the Honorary Secretary of the bank as the agent and local representative of the Federation. It is not essential that it should be so entrusted, and from time to time in some Central Banks members of the Federation staff have been placed to work under the chairmen of local Unions and well-known *sirpanches* of primary societies, and in the event of any abuse of the kind indicated by Mr. Willoughby in his report it would be open to the Governor of the Federation to entrust the supervision of the local Federation staff to any other co-operator or several other co-operators as agents of the Federation.

Mr. Ewbank quotes at length the analogy which Mr. Crosthwaite draws[1] between the units of the co-operative system and the units of the Army, and concludes, "the gospel of centralization

[1] "Co-operative Studies and the Central Provinces System," part III, chapter I.

could scarcely be preached in a more unequivocal language." It is always dangerous to extract quotations without reference to their context, and a very cursory perusal of the chapter referred to would convince the reader that the author's intention was not to preach centralization but to combat excessive individualism and to show that discipline is implied in co-operation whether it be co-operation of individuals or of societies. The opening words of the chapter read :

"The main principle upon which the Central Provinces system of co-operation is based is that, apart from the necessary control by Government of a movement deeply affecting public interests, nothing must be done for co-operators (*i*) which they ought to do for themselves, (*ii*) which they are competent to do for themselves"; and again later,[1] "Quite a common idea among the educated pioneers of the movement is that, though Central Banks can be managed by them, the village societies cannot and need not be managed by their members. That is to say, self-government may be very good for a Central Bank but is very bad for the societies working under that bank. It is difficult to understand the reasoning which permits sincere and thinking men to fall into an error of this kind. Unless the societies are instructed and patiently trained, they will never know what self-help is, and unless they are left to apply what has been taught them, they will never know what self-help means. A Central Bank which does not train its societies to independence is not doing its duty and is working on lines which are not only wrong but injurious to the country."

Surely it is not centralization but decentralization to the widest extent compatible with co-operation which is here preached. But co-operation implies discipline and self-sacrifice ; this is clear enough in the village society, and it would appear illogical and inconsistent to emphasize the importance of discipline and self-sacrifice among the individual members of a primary society and to deny the necessity when co-operation advances a step further and becomes co-operation between societies instead of between individuals

[1] *Ibid.*, paragraph 253.

The truth is, the Central Provinces system is not a centralized but an unified system. The whole co-operative movement is regarded as a single body in which each member performs its proper function. Issues which can be decided by the primary societies cannot be decided by the individual members of such societies; so also while some functions must be entrusted to the Directors and members of the Central Bank as representing the societies in a district, other functions must be entrusted to the Co-operative Federation as representing the whole movement. We recognize that co-operation does not begin and end in the village. There must be co-operation between societies working upwards from the Circle Unions to the Central Bank and Provincial Bank, and when the time comes, the All-India Federal Bank, and each part of the co-operative organization should perform those functions for which it is best fitted. One of the illustrations which Mr. Ewbank gives of matters in which the liberty of primary societies is unduly fettered is the investment of reserve fund and the purchase of shares by primary societies in the Central or Provincial Banks. Why, he asks, should the societies be compelled either to take shares in the Central Banks or to invest the reserve fund outside their own societies? We should reply that the members of primary societies are incapable of investing their reserve funds in any other way than in their own working capital because they are not sufficiently advanced to appreciate the matters at issue. It will of course not be disputed that an agricultural society, even though extremely advanced, could not be expected to appreciate the rival merits of the English War Loan and the Indian War Loan in the present state of exchange: and any investment of this sort as a matter of course would have to be done for them. But leaving minor points like this on one side, we would maintain that inasmuch as the reserve fund represents in the Central Provinces the whole, and in other provinces a very large portion, of the profits of primary societies, the whole future of the movement depends on its proper utilization. If the primary societies, that is to say the agricultural classes, are ever to own their own Central Banks and their own Provincial Banks, then the investment of the reserve fund must at present be left in the hands of the more

enlightened people in whom the primary societies by electing their as their representatives have displayed their confidence. If an All-India Federal Bank is ever to be more than a dream, it is to the accumulated reserve fund of primary societies that we must look for the capital necessary to establish such a Federal Bank. Further, if the agricultural classes are ever to advance, if they are ever to learn to manage their own affairs, and by their chosen delegates the affairs of Central Banks, Provincial Banks, and the All-India Federal Bank if established, it is to the educative influence of representative institutions as displayed in the Co-operative Federation that we must look for the necessary stimulus to raise them from the apathy and indifference in which they are now sunk.

MANURES IN THEIR RELATION TO SOILS AND CROP PRODUCTION IN THE CENTRAL PROVINCES.*

BY

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THE four principal soils of the Central Provinces are the alluvial soils of the Nerbudda valley which corresponds to the wheat tract, the black cotton or trap soil of the cotton tract, and the lateritic and metamorphic soils of the rice tract. Without manure and irrigation most of the area under these soils has reached the stage of maximum impoverishment and now yields approximately 600 lb. of wheat, 300 lb. of *kapas* (unginned cotton), and 900 lb. of paddy per acre, respectively, without irrigation. Given irrigation without manure, the crop outturns are increased by approximately 100 lb. of wheat, 30 lb. of *kapas*, and 550 lb. of rice per acre, respectively.

If cattle manure were available in sufficient quantities at present prices, there would be little chance of finding any other manure which could compete with it. But in the Central Provinces much of the cattle-dung is used as fuel, and in most districts, even that part of it which in the rainy season cannot be dried as fuel is left exposed in an open heap together with the ashes of dung which has served its purpose as a fuel. Ordinary village manure made in this way contains on an average 0·46 per cent. of nitrogen, while cattle manure properly stored on Government farms in the provinces contains 0·68 per cent. Nitrogen which is the one constituent

* A paper read at the Fifth Indian Science Congress, Lahore, January, 1918.

in which our soils are so deficient happens to be the particular one which is wasted to the greatest extent by the cultivator, for in the process of burning, over 97 per cent. of the nitrogen of cattle-dung is dissipated. It has been proved, too, that the rain of tropical countries in general does not supply the soil with a greater amount of nitrogen than the rain of temperate climates, the average total for tropical countries being only 3·54″ per acre annually. While the quality of cattle manure is very poor, the quantity available every year is very small, being only about one cartload per acre of crop grown. If every field were to be manured at intervals of 8 years, the quantity of manure available per acre would only be about 64 mds., or approximately 8 cartloads. But a very considerable part of the total quantity of cattle manure used is, as a matter of fact, applied not to the fields in which our staple crops are grown but to cane and garden lands. This unequal distribution of the supply still further reduces the quantity available for open field cultivation. How to meet this deficiency in the supply is one of the problems to which the Agricultural Department has been giving serious attention for the last 12 years, and a large programme of manurial experiments has been carried out on the Government experimental farms with the view of finding manures which can be used to supplement the very inadequate supply of cattle-dung at present available. In describing the results obtained I shall confine my remarks to the rice and cotton tracts with which I am better acquainted.

The application of enough cattle-dung to supply 10 lb. of nitrogen per acre has added from Rs. 10 to Rs. 15 to the net acreage profit on rice cultivation. The same amount of nitrogen applied as poudrette has increased the net profit by from Rs. 15 to Rs. 20, while the same quantity applied as night-soil has increased it by from Rs. 20 to Rs. 30 per acre. The application of calcium cyanamide and of bonemeal separately and of bonemeal in combination with saltpetre has resulted in a dead loss. Bonemeal combined with sulphate of ammonia has generally given a small profit as have also dried leaves and tank silt. Castor cake has given a small net profit in some series only: in others its application resulted in a loss.

The only manures which have consistently given large acreage profits are cattle manure, night-soil, and poudrette. The supply of night-soil and poudrette is so small and the difficulty of getting sweepers to apply them so great that they are only of secondary importance as an economic factor in crop production. It therefore becomes evident that of the manures available in any quantity cattle-dung is the only one which really counts. The use of green manures therefore suggested itself as being the most likely method of finding a substitute for cattle-dung. Owing to the peculiar nature of our rainfall which extends from the middle of June to the end of September, a period which coincides with the period of greatest growth of the rice plant, the only crop which is at all suitable as a green manure for rice is a fast growing one which, when sown in the middle of June, will be ready for application by the end of July at which time the seedlings are being transplanted. Sann-hemp (*Crotalaria juncea*) has been found to be a sufficiently fast grower, but when grown in the bunded rice plots its growth is checked so much by the heavy rainfall of the early monsoon that it is found impossible to raise any quantity of it in time for ploughing in for the succeeding rice crop. *Dhaincha* (*Sesbania aculeata*) thrives much better under the same conditions, but is too slow a grower. The difficulty in producing a sufficient bulk of *sann* has been finally got over by growing it in the open fields reserved for *rabi* (winter) crops. In one acre of *rabi* land about 300 mds. of *sann* per acre can be grown in time for ploughing in for rice. This suffices as a green manure for 3 acres of rice. The analysis of this green sann-hemp showed that it contains 0·57 per cent. of nitrogen, so that it is about equal in manurial value to cattle-dung bulk for bulk. Over the greater part of the rice tract of the Central Provinces, the *rabi* or winter crop area lying fallow during the rains and therefore available for the production of sann-hemp as a green manure for rice, is almost equal to the area under rice. It is possible therefore to raise much more green manure than is needed for rice and without reducing the area under *rabi* crops such as wheat, gram, linseed, etc. The practice will, we believe, be a positive advantage, as far as *rabi* crops are concerned, as the standing crop of *sann* helps to check the

growth of weeds and to reduce to a minimum the damage which would otherwise be done to the fields left fallow during the monsoon. The manurial value of the roots of the *sann* for the *rabi* crop should also be appreciable. Experiments to test it have been started. This new method by which fallow land is utilized for the production of green manure for rice, is applicable to over 4 million acres of rice land in the Central Provinces, and I anticipate that it will largely solve the manurial problem as far as the rice tract is concerned. It was tried by landowners in over 40 villages last year. The average increase obtained from the fields manured in this way amounted to over 600 lb. of paddy per acre, worth approximately Rs. 15. The cost of raising this green manure was about Rs. 3 per acre manured, leaving a net profit of Rs. 12 per acre.

The use of cake as a cane manure was demonstrated by the Department for the first time six years ago. This manure, though not previously in use anywhere in the provinces, has now caught on, and is being used in larger quantities every year by cane-growers. Sann-hemp, applied at the rate of 10 tons per acre to the sandy loams in which cane is generally grown in the rice tract, has, when supplemented by a dressing of 15 mds. of cake, given yields of about 20 tons of cane per acre, which, when converted into *gur*, is worth approximately Rs. 330. The cost of the manure applied in this case is only Rs. 33. The average outturn of cane for the provinces, manured with cattle-dung, is only 11 tons, which is worth approximately Rs. 184. By this new method of manuring the net profit on cane cultivation can be increased by about Rs. 146 per acre.

In the cotton tract the value of manure is more highly appreciated than in other parts of the provinces. Cotton pays better than rice or wheat, and cultivators have come to realize the economic value of cattle manure. The price per cartload is R. 1 as against 8 annas for the greater part of the rice tract. But in the cotton tract, too, much valuable manure is wasted. No attempt is made to conserve the urine which is so rich in nitrogen. To meet this formidable obstacle to good cultivation, the dry-earth system of conserving urine has been demonstrated in this tract. Experiments

arried out with urine earth on the Government farms have shown hat, in the year of application to *jowar* (*A. Sorghum*) and cotton ields, the urine of a bullock for any definite period of time, is equal n manurial value to its solid excreta for the same time. By this ystem of conserving the urine, dry earth to a depth of 6″ is spread n the stalls. This earth is removed to the manure pit once a month, nd fresh earth is put into its place which, in turn, absorbs the quid portion of the animal's excreta for the succeeding month. By adopting this system of conserving cattle urine the intrinsic value of the manurial supply of a village can be doubled at a very small cost.

Cotton cultivation on well manured land is so profitable at the prices which have prevailed of recent years that it would pay the cultivator to manure his cotton, even if cattle manure were three times as expensive as it is at present. The supply, however, is so very inadequate that there is none available for sale in the villages. Green-manuring is not a feasible proposition in this tract as it would have to be grown at the expense of cotton and *jowar*, for the manuring of *rabi* crops of which the area is comparatively small. To meet the full requirements of the cotton tract, therefore, it will be necessary to fall back on manures not at present in use, and this we hope to be able to do by the use of nitrate of soda on a large scale, and by the utilization of such quantities of manurial cakes as are manufactured locally. If it were possible to offer nitrate of soda for sale at about Rs. 10 per cwt., the demand for it would, I believe, be large. On the strength of the results obtained from the trials of nitrate of soda on the Akola farm, the Commissioner of Berar put up a proposal this year to the effect that about a lakh of rupees worth of this artificial should be offered for sale to cotton-growers in his division which constitutes the greater portion of the cotton tract. The price, however, had risen so enormously owing to the war that it was considered inadvisable to make large purchases at the present time. There is little doubt but that it would pay handsomely to apply nitrate costing Rs. 10 per cwt. as a topdressing to cotton at the rate of 60 lb. per acre. This quick-acting manure is specially suitable for short-season cottons.

In conclusion, I should like to lay stress on the fact that though in the Central Provinces and in other parts of India much has already been done by the Department of Agriculture to solve the problem of economic manuring, a poor cultivator will not be in a position to reap the full benefit from the results of these researches until we make it easy for him to obtain these manures. We require, in short, an efficient organization which will provide both for the supply of manures and for the financing of purchasers who wish to buy them. This may possibly be done later on a large scale through co-operative societies. To pave the way for co-operative societies it may be necessary to finance the cultivator direct to start with. It should be quite feasible for Government to provide a definite sum to be given each year as *takavi* for the extension of agricultural improvements recommended by the Department of Agriculture. This has, as a matter of fact, been done in the Central Provinces, and it is a policy which is well worth the consideration of any provinces which may not yet have adopted it.

NOTES ON THE HYDROCYANIC ACID CONTENT OF JOWAR (*ANDROPOGON SORGHUM*).

BY

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It has long been known that a cyanogenetic glucoside, called dhurrin, is present in *jowar* in certain stages of its growth. This glucoside is not poisonous by itself, but it breaks up, in contact with an enzyme which is present in the plant tissues, into several compounds, one of which is hydrocyanic acid. It is on account of the formation of this latter substance that *jowar* acts as a poison, and cases of poisoning of cattle by the plant are not of infrequent occurrence. In 1915 a number of cattle deaths took place near Sabour. That year there was a particularly long period of dry weather immediately after the crops were planted, a condition which does not happen every year. It was then suggested that, owing to the insufficiency of moisture in the soil, the plants were stunted and did not grow properly, and that, in consequence, there was an excessive development of the cyanogenetic glucoside which yielded the poison. It was then proposed to investigate the circumstances which help the accumulation of the poison-producing compound in the *jowar* plants.

Accordingly, at the suggestion of Mr. Somers Taylor, Agricultural Chemist to the Government of Bihar and Orissa, a trial was made to find out the effects of different times of planting, and also of water-logging, on the formation of the glucoside in *jowar*. The idea was to sow some of the plots very early, well in advance of the usual time, so as to obtain, as far as possible, a condition similar to that of 1915, *viz.*, a period of comparatively dry weather in the

growing period, and also to sow some of the plots very late, after the rains have well set in, so as to have always an excessive quantity of moisture in the soil. Unfortunately the rains were late in coming, so late as to make very early planting impossible, and there was no abatement of rains once they had set in, so that the first condition of comparative drought was not obtained. On the other hand, owing to heavy and frequent rain, all the plots were water-logged, and the plants, weak and stunted, even after six weeks, showed no tendency to grow up at all. A very small quantity of hydrocyanic acid was all that was obtained—a fact which suggests that water-logging is unfavourable to the formation of cyanogenetic compounds in *jowar*. There was no case of cattle-poisoning* that year by *jowar*. The following table illustrates the result :—

TABLE I.

Age of plants	Date of analysis	HCN%
Plot No. I E. P.		
Over 4 weeks ...	6th July 1916	0·000912
5 ,, ,,	9th ,, ,,	0·000456
Over 5 ,, ...	12th ,, ,,	0·000500
Over 6 ,, ...	18th ,, ,,	Traces
Plot No. II E. P.		
4 weeks ..	6th July	0·000608
About 5 ,, .	9th ,,	0·000512
Over 5 ,, ..	12th ,,	0·000456
Over 6 ,, ..	18th ,,	Traces

The experiment was repeated in 1917. The first of the plots were sown on 12th May. Before that there were only two inches of rain distributed over six days, and there was no rain after until the 27th May. But just on the night previous to the day when the first samples were collected, there was a shower ($\frac{1}{2}$ inch) of rain, so that the actual condition of the plants during the period of drought was not exactly known. An excessive quantity of prussic acid was found, which, however, fell down to less than half in about three weeks, during which period there were occasional showers.

* A few cattle deaths reported from Bettiah were suspected to be due to the cattle eating a weed, *Andropogon helepensis*, which is also, like *jowar*, capable of yielding HCN. But at the time the weeds were collected and received at Sabour for examination, no HCN was obtained from them.

The results were not even on all the plots.

TABLE II.

Date of analysis	Plot I E. P.	Plot II E. P.	Plot III E. P.
	HCN%	HCN%	HCN%
28th May ...	.....*	0·196*	.....*
5th June ...	.....*	0·099*	.....*
8th ,, ...	0·121	0·092	0·124
12th ,, ...	0·060	0·045	0·057
19th ,, ...	0·075	0·025	0·021
26th ,, ...	0·041	0·004	0·013
3rd July ...	0·032	0·009	0·008
10th ,, ...	0·019	0·003	0·009
17th ,, ...	0·024	.....	.....
31st ,, ...	0·012	.....	.....
13th August ...	Traces	.....	.....

The poisonous properties most persisted in the plot E. P. I. This plot was, however, marked by a more vigorous growth, as is evident from the greater average weight of the plants, and also by the greener and more healthy appearance of the leaves (Table III).

TABLE III.

Average weight and height of a plant.

Date	Plot I E. P.		Plot II E. P.		Plot III E. P.	
	Weight	Height	Weight	Height	Weight	Height
3rd July ...	122 gms.	150 cm.	108 gms.	170 cm.	112 gms.	180 cm.
10th ,, ...	338 ,,	200 ,,	293 ,,	200 ,,	245 ,,	200 ,,
17th ,, ...	367 ,,	250 ,,	.....	.....	267 ,,	200 ,,

Here is a result which is contrary to all expectations, for it has long been believed that a healthy and vigorously growing *jowar* plant yields much less poison than its weak and stunted brother. This result received a remarkable confirmation from the observations of some later plants. In the case of thickly sown plants, what always happens is that a good many receive a much later start and lag behind, in the matter of growth, their stronger and older brothers. This may be due to malnutrition or to the secretion of injurious products by the older plants, but that strong and healthy plants contain more prussic acid can be seen from the following table :—

* As the plants were then very small, the samples collected from the three plots were analysed together.

TABLE IV.

Plot IV (Usual time).

Date of analysis	Average weight	Average height	HCN%
16th July, 1917 ...	17 gms.	80 cm.	0·0080
	81 ,,	127 ,,	0·0151
23rd July, 1917 ...	22 ,,	100 ,,	0·0090
	143 ,,	170 ,,	0·0153
30th July, 1917 ...	26 ,,	96 ,,	0·0075
	191 ,,	200 ,,	0·0047
	Plot V (Usual time).		
16th July, 1917 ...	17 gms.	75 cm.	0·0076
	122 ,,	120 ,,	0·0190
23rd July, 1917 ...	32 ,,	85 ,,	0·0053
	117 ,,	160 ,,	0·0065
30th July, 1917 ...	12 ,,	95 ,,	0·0128
	244 ,,	196 ,,	0·0110
6th August, 1917 ...	26 ,,	119 ,,	0·0045
	547 ,,	216 ,,	Traces

The time of planting does not appear to have any effect on the formation of dhurrin. With the three sets of plots sown at different times, and nearly at a month's interval between one and the next, there was no difference between the first and the second set, both as regards the maximum yield of the poison or its rate of diminution as the plants grew up, but the third only showed half the maximum quantity of the poison, though the rate of diminution of the poison was very much the same. The low maximum of the third set which was planted last at a time (8th July) when there was an excessive amount of moisture* in the fields, and when there were heavy downpours of rain previously and subsequently to the sowing, may be due to an abundance of soil moisture.

The following table is given for comparison :—

TABLE V.

Plot III L. P.			Plot II E. P.			Plot IV U. P.		
Date of sowing	Date of analysis	HCN %	Date of sowing	Date of analysis	HCN %	Date of sowing	Date of analysis	HCN%
8-7-17 ...	25-7-17	0·0452	12-5-17	23-5-17	0·1960	7-6-17	25-6-17	0·0910
	1-8-17	0·0381		5-6-17	0·0090		2-7-17	0·0090
	9-8-17	0·0279		8-6-17	0·0920		9-7-17	0·0210
Planted very late.	15-8-17	0·0285	Planted	12-6-17	0·0450	Planted	16-7-17	0·0093
	21-8-17	0·0173	very	19-6-17	0·0250	at the	23-7-17	0·0035
	29-8-17	0·0148	early.	26-6-17	0·0042	usual	30-7-17	0·0091
	5-9-17	0·0050		3-7-17	0·0093	time.	6-8-17	0·0075
				10-7-17	0·0031		14-8-17	Traces
				17-7-17	Traces			

* See Table of Rainfall (Table VII).

It is therefore obvious that while the time of planting by itself has little or no connection with the formation of the glucoside, yet a crop planted late has a much better chance of producing smaller quantities of the poison on account of the abundant moisture which is generally found in the soil in such a time.

Dhurrin occurs principally in the leaves and young shoots. There is a very much smaller quantity of it in the stalk, from the time the plant grows to an appreciable height, *viz.*, about 100 cm. The percentage of total nitrogen in the leaves is also proportionally greater than in the stalks, evidently owing to an accumulation of non-protein nitrogenous matter (Table VI). In ratooned *jowar*, when young shoots spring up from old stalk, the *jowar* is considered to be highly poisonous, although the parent stock at the time might contain practically no glucoside. This occurrence of the glucoside, specially in the places of active metabolism, is suggestive of some compounds being formed and fixed by the plant in such forms.

The exact part played by it in plant economy can only be known when the factors influencing its formation are known with certainty. The cyanogen may be an intermediate product in proteid formation, or it may act as a harmone, which is the general name of a variety of substances which are able to penetrate the walls of plant cells, thereby disturbing the equilibrium within the cell and producing changes which involve alterations of the concentration and the liberation of hydrolytic enzymes. If the former view be correct, it would signify that strong and healthy plants, which form more proteids than weaklings, would gather more glucoside at a time when proteid formation is very active. It is very suggestive that the total nitrogen percentage in a plant shows more or less a steady diminution as the plants grow up, but not at such a rapid rate as the hydrocyanic acid. No reliable evidence has been obtained that weak and sickly plants can produce, as a rule, more hydrocyanic acid ; in fact, evidence, as far as has been obtained, points to the contrary. Let us examine the factors which have so far come to our knowledge as likely to bear on the production or otherwise of the glucoside. In the first place, an abundance of moisture in the

soil is always associated with a low percentage of dhurrin, and sickly plants growing in water-logged soils contain only a minute quantity. The contrary is also probably true, in spite of scanty experimental evidence, *viz.*, a deficiency of moisture in the soil or a dry period is conducive to excessive glucoside production in *jowar*. There is no doubt that the experience of the general body of cultivators is in favour of this view, and here and there facts have been brought out suggestive of it, but apart from that, no further experiments appear to have been carried out which would fully bear out the cultivators' views. Secondly, the rate of growth has long been thought to have some correlation to the poison-producing power in the plant, the most poisonous plants being those which make a very unfavourable growth. It has been shown that this is not necessarily true, and that in the case of strong and weak plants growing side by side in the same field, it is not the weak plants alone which always yield the greater amount of hydrocyanic acid. Thirdly, there is a far greater amount of nitrogen accumulation in the leaves than in the stalks. The appearance of this greater quantity of nitrogenous substances exactly in the parts where the greatest quantity of hydrocyanic acid occurs, is an indication that the production of the glucoside is in some way correlated with the production of the nitrogenous matter, and lends support to the theory that prussic acid is an intermediate product in proteid formation, and that its occurrence is an evidence of nitrogen assimilation. Water-logging presents a very unfavourable condition for nitrogen assimilation, as it prevents bacterial activity and stops nitrification. This accounts for the production of merely traces of hydrocyanic acid in the crops of 1916. In warm dry weather, before the rains have actually fully set in (according to Leather's drain-gauge experiments at Pusa[1]), the seat of nitrification is much nearer the surface and therefore presents a more favourable condition for nitrogen assimilation by the young plants whose roots at the time do not penetrate deep enough. With the coming in of the rains the principal seat of bacterial activity

[1] *Memoirs of the Department of Agriculture in India, Chemical Series*, vol. II, no. 2.

noves downwards, and there is a likely loss of soluble nitrates by overflooding and drainage, and partly on this account and partly on account of the very rapid rate of growth, when the glucoside formed is rapidly utilized to furnish higher and more complex compounds, there is less and less hydrocyanic acid obtained as the plant grows up until it is fully grown. Thus the accumulation of the acid in the young plant in normal years and its diminution with the age and growth of the plants receive an explanation. But in years of scanty rainfall, as the vital activities of the plant are retarded on account of lack of moisture, the utilization of the cyanogenetic compounds will probably take place much more slowly, and the plant will indicate a quantity of the poison which it cannot at once get rid of. These are, however, still suggestions and have to be substantiated in the light of further experiments.

It would therefore appear that the weather is mainly responsible for the development of the poisonous elements in the *jowar*. The soil is only of minor importance and is accountable only so far as it can hold up nitrogenous food materials to the plant. Brunich in Queensland found that the poisonous properties of *jowar* increased with improved fertility, and Treub[1] stated that nitrates exert a direct influence on the production of hydrocyanic acid. Against this there are American results[2] that in a rich soil, however well provided with plant food, an addition of nitrogenous fertilizers has been found to exert no appreciable effect, while in a poor soil there appears to be an increase, though to a slight extent. The soil, therefore, though it may help in the production of the glucoside, is only a minor factor, and the weather, notably rainfall, is the factor of greater importance.

It is proposed to continue the study still further.

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[1] Treub, M. *Ann. Jard. Bot. Buitenzorg*, 2. ser. 4. pt. 2. pp. 86-142 (noted in *Expt. Station Record*, vol. XVII, p. 347).

[2] *Journal of Agricultural Research*, vol. IV, no. 2.

TABLE VI.

Showing the percentages of hydrocyanic acid and of nitrogen in different parts of jowar *plants at different stages of growth.*

Plot No.	Date	HCN%	N%	HCN% in leaves	N% in leaves	HCN% in stalk	N% in stalk
E. P. I ...	8-6-17	0·12100	0·5060				
	12-6-17	0·06000	0·6260				
	26-6-17	.....	.....	0·0128	0·500	0·00750	0·201
	3-7-17	0·03240	0·5130	0·0565	0·677	0·01660	0·404
	10-7-17	0·01870	0·4580	0·0452	0·754	0·00603	0·316
E. P. II ...	8-6-17	0·09200	0·4030				
	12-6-17	0·04500	0·4920				
	19-6-17	0·02500	0·3730	0·0230	0·495	0·01500	0·161
	26-6-17	0·00420	0·3880	0·0075	0·547	0·00380	0·26
	3-7-17	0·00930	0·3580	0·0143	0·630	0·00600	0·32
E. P. III ...	8-6-17	0·12400	0·4200				
	12-6-17	0·05700	0·4750				
	19-6-17	0·02100	0·3260	0·0300	0·496	0·05100	0·21
	26-7-17	0·01260	0·4460	0·0136	0·547	0·01130	0·33
	3-7-17	....	.....	.....	... ..	0·00750	0·20
U. P. I ...	25-6-17	0·09100	0·4650				
	2-6-17	0·09040	0·6040				
	9-7-17	0·02110	0·4820				
	16-7-17	0·00792	0·6640				
Stunted plant) ...	23-7-17	0·00905	0·3504				
(Strong plant) ...	23-7-17	0·01530	.....	0·0317	0·299	0·00603	0·02
(Stunted plant) ...	30-7-17	0·00754	0·2030				
Do. ...	6-8-17	0·00151	0·2940				
U. P. V ..	25-6-17	0·82900	0·4800				
	2-7-17	0·82600	0·6160				
	9-7-17	0·21609	0·5060				
	16-7-17	0·00758	0·4970				
	23-7-17	0·00650	.....	0·0098	0·208	0·00452	0·0
(Stunted) ...	30-7-17	0·01280	0·2080				
	6-8-17	0·00452	0·2740				

TABLE VII.

Table of rainfall in inches, May to August 1917, *recorded in the Sabour Agricultural Station.*

Day of the month	May	June	July	August
1	.....	1·95	0·07	2·17
2	.....	.....	.....	3·33
3	.....	.....	0·70	0·45
4	0·43	.....	3·45	0·20
5	0·03	.....	.....	.....
6	0·85	.....	.....	.....
7	0·05	.....	.....	.....
8	.....	.....	0·07	0·12
9	0·03	0·40	.....	0·45
10	.....	.....	.....	0·48
11	0·72	.....	0·31	1·53
12	.....	.....	.....	1·00
13	.....	.....	1·40	0·04
14	.....	0·46	.....	0·14
15	.....	0·58	.....	0·04
16	.....	.....	.....	.....
17	.....	.....	.....	.....
18	.....	0·17	0·16	0·96
19	.....	.....	0·15	.....
20	.....	.....	.....	.....
21	.....	0·32	.....	0·04
22	.....	0·15	.....	.....
23	.....	0·61	.....	.....
24	.....	.....	1·57	.....
25	.....	0·50	0·28	0·27
26	.....	.....	0·30	.....
27	0·59	.....	1·48	0·34
28	0·33	.....	0·50	.....
29	.....	.....	.....	.....
30	0·63	0·55	0·34	.....
31	.....	.....	.....	.....

GRAFTING THE GRAPE-VINE.

BY

H. V. GOLE,

Grape-grower, Nasik.

WE have great pleasure in publishing this article by an actu cultivator who has made experiments on his own accou and hope it would be of special interest to the readers of t Journal. It is needless to add that contributions from intel gent, practical cultivators, embodying the results of th experience, observations and experiments, will always welcome to us.—[EDITOR.]

AMONG other advantages of grafting the grape-vine, it is claim that the effect of grafting is to produce a constant weaken of the scion with increased fructification, a greater number closely set bunches with large berries, more juicy and frequent richer in saccharine matter, and an early ripening.[1] Husmann also believes that grafting increases fruitfulness, the temporary obstru tion seeming to have the effect upon the graft of making it produ more and finer fruit than on its own roots.[2] He has also recorde similar experience of other eminent growers.

The matter seemed worthy of investigation and led me undertake a few experiments as already remarked in Bulle No. 71 (of 1915) of the Bombay Agricultural Department. T principal varieties of grapes grown at Nasik are only four. Bhok

[1] Viala and Rivaz. "Grafting for American Vines."
[2] Husmann. "Grape-growing and Wine-making."

being a good cropper, is much in favour and largely grown, while Bhokari, Sahibi, and Hafsi or Kali, being very shy bearers, are never grown beyond a few vines in a plantation, though these varieties are decidedly superior. If grafting produced increased fruitfulness the problem here was to ascertain whether some of our shy bearers could be made to yield more and better fruit by grafting them on other stock.

I had no clear notions about the influence of the stock upon the scion. I vaguely imagined that Bhokari, being very prolific, might exert a favourable influence upon the scion. Also, as Fakari, Sahibi, and Kali are very vigorous growers, producing abundant foliage—perhaps at the expense of fruit—I should be able to check this habit of vigorous growth by selecting a stock which was a moderate grower by habit, such as Bhokari. On these considerations I decided to use Bhokari as stock.

The next point was to select the method of grafting. Various methods of grafting and budding have been suggested. As I had very little experience in grafting, I chose to operate in four different manners, namely :—

(1) Grafted cuttings,
(2) Grafting by approach,
(3) Crown grafting, and
(4) Side-cleft grafting.

Grafted cuttings.

For successful grafting it has been found that the temperature should not exceed 20° or 25°C. As cuttings could only be obtained the beginning of October, I tried grafted cuttings at this time, though the temperature condition was not favourable. All the trials failed successively for three years (1914 to 1916). In preparing the graft the cut has to be made one-half to one inch above and below a node upon the stock and scion respectively. This gives the knitting surface much too small. The grafted cuttings should have been kept for callusing in fresh moist sand before they were set to root. I admit that I had not followed this instruction.

Be it from whatsoever cause, none of the grafted cuttings rooted and I gave up the trials after three years.

GRAFTING BY APPROACH.

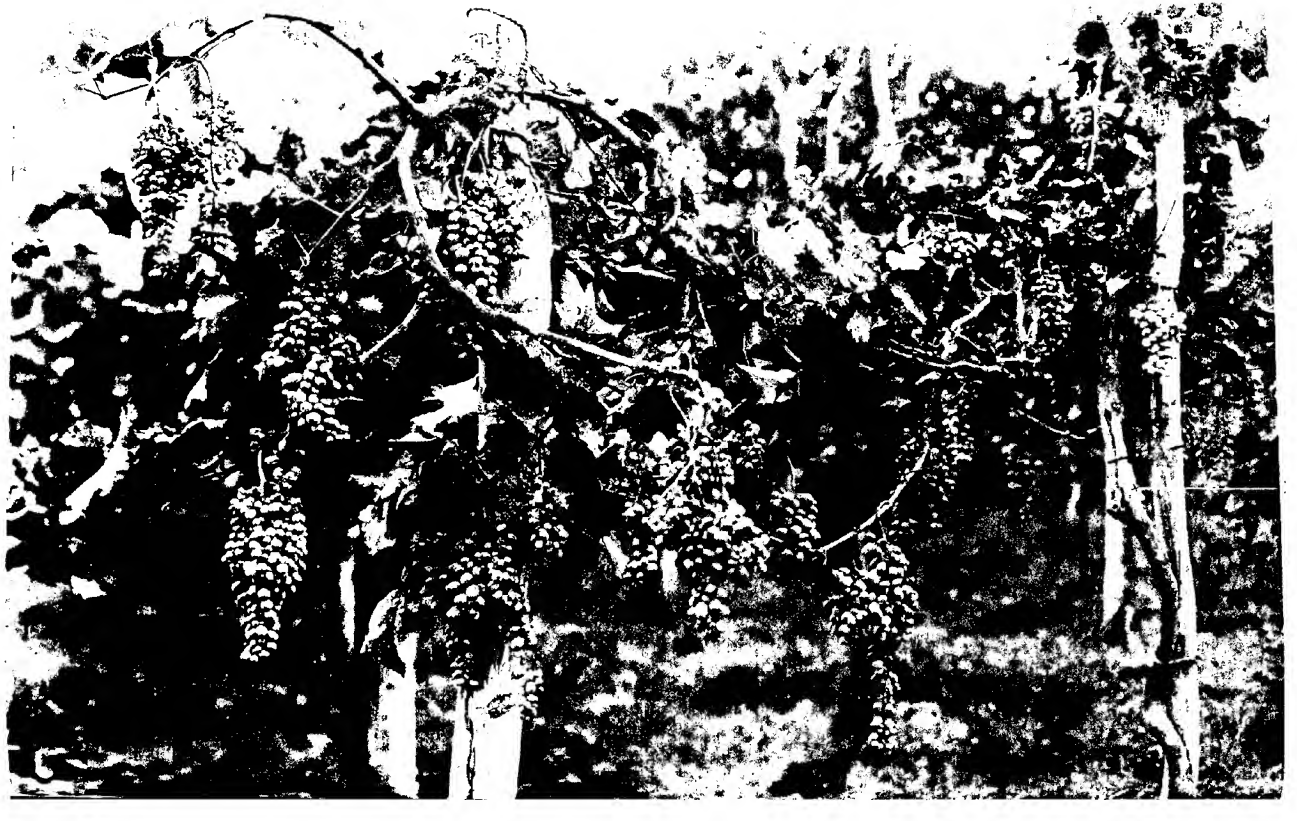
In 1913 a *mali* from the Ganeshkhind Botanical Garden Kirkee, grafted on two Bhokari vines in one of my plantations operating by the usual method of grafting by approach (tongue graft). Both the grafts knitted well and were successful. Fakan canes were used for scions. Both grafts were pruned in April, 191 to form the head. One of the grafts was accidentally destroye while ploughing. The other graft was again pruned for fruit October, 1914. The stock of this graft is 40″ long and the sci after heading in was 24″ long. It gave six bunches of good siz while there were only four small bunches on the parent vine, that from which the scion was taken. The result was tolerably fair an encouraging. This graft is bearing splendidly every year.

I have found that grafting by approach is a much surer meth the grafts knit well and the chances of failure are few. I ha other grafts prepared by the approach method. One is bearin fruit beautifully. The length of the stock is 24″ and that of t scion after heading in is 40″. Three other grafts had to be tra planted elsewhere in April, 1917, as they happened to be in a isolated condition, but they have not as yet recovered from t shock.

But there is one disadvantage with this method. As t number of vines for the scion is only limited in a given plantatio only a few vines can be grafted by this method. I thought trying a method which shall be quite independent of the positio of scion vines, which is described below.

CROWN GRAFTING AND SIDE-CLEFT GRAFTING.

In October, 1914, I tried 10 crown grafts and 10 side-cleft graft Four crown grafts were put up below the ground and the rest abo the ground. Only one graft above ground knitted well and wa successful. Again, in the following year, out of nine crown graft and nine side-cleft grafts, only one crown graft above ground wa



successful. The trials in 1916 and 1917 failed to give even a single successful graft. From this it appears that crown and side-cleft grafting are much more difficult and cannot be practised as a general method.

So far my object had not been attained. I wanted to find out a method of grafting by which the variety of any existing plantation can be changed at will. A new plantation can be put up by growing together and training mixed cuttings of different varieties, and when the heads are formed, the choice variety may be grafted upon another stock by the approach method. I have obtained a few grafts in this manner. But it takes up much time to train the vines before they can be grafted upon and, therefore, foreign varieties cannot be propagated rapidly by this method, nor can their possibilities judged within a short time. Crown and side-cleft grafting have a greater significance in the case of untried and foreign varieties; for, by these methods, these varieties can be introduced rapidly and their possibilities judged.

Results.

As a general rule, Fakari vines on their own roots bear quite indifferently. They will not bear fruit at all or bear a few bunches which are quite out of proportion to the large bearing surface on the head of the vines. All the grafts are bearing fruit regularly from the very second year. The quantity of fruit will depend on the bearing surface. As the age of the grafts advanced, the heads were well formed and the bearing surface had increased. There was a corresponding increase in the number of bunches and the weight of the fruit. I am writing this from my observations. I have not kept regular records. Last year the weight of fruit on the graft (approach graft of 1913) must have been 15 lb.; the other approach grafts yielded nearly seven pounds of fruit; the two crown grafts bore quite to my expectation. This year the approach grafts of 1913 had 42 bunches, which weighed 22 lb. (Birds are responsible for considerable loss of weight; only the actual weight is given.) The other approach grafts had 19 bunches which weighed 14 lb. The photograph of one of these two grafts (Plate I) will give a

good idea of the number and size of bunches. The number of bunches on the crown graft of 1914 was 17 and weighed 7½ lb., while the other crown graft of 1915 gave 13 bunches which weighed 6 lb. The bunches on both the grafts were mildewed, which circumstance has adversely influenced the weight. Many of the bunches were of large size. The berries attained normal size. On the other hand the berries on some bunches were undersized. Near each crown graft (close to it) is a companion or sister Bhokari vine which is also in bearing. The grafts are not photographed as it was difficult to isolate their bearing canes from Bhokari for the purpose of photographing. In one of my plantations there are 150 Fakari vines on their own roots. They bear fruit indifferently and are not even paying the cost of their cultivation. This is the first time in five years that they have borne fruit to an appreciable extent. The total weight of fruit on these 150 Fakari vines was 296 lb., or a little less than 2 lb. per vine. The average yield from Bhokari vines is 12 lb. to 15 lb. Individual Bhokari vines do bear 20 lb. to 25 lb. of fruit. From these figures it will be seen that the grafts gave considerably increased quantity of fruit, far in excess of the average of 2 lb. on the 150 Fakari vines on their own roots.

Conclusion.

It appears that grafting the grape-vine increases fruitfulness. The grafts give larger and closely set bunches. In some bunches the berries attained normal size, while in others they are undersized. The quality of the fruit is not changed appreciably. From the behaviour of four grafts, it is not safe to assert, as a general proposition, that grafting produces fruitfulness. The indications are however, that it does produce increased fruitfulness. More experimental work is necessary. Experiments generally do not pay and are even costly. In other experiments with the grape-vines—such as summer pruning or pinching and spraying with ammoniacal copper carbonate solution against mildew—I have gained; while in trying the crown grafts I have lost 40 well-established vines and permanently injured 40 vines by side-cleft grafting. Besides, such experiments in experienced and capable hands are likely to be

more successful. If the record of my experiments be deemed interesting I hope others will undertake further experimental work.

Next cold weather, I shall grow and train 60 sets of mixed cuttings. Every set will consist of 4 cuttings, two of Bhokari and two of choice variety. Bhokari will be used for stock. For the scion, cuttings of Fakari, Sahibi, Kali, and Kandahari will be grown.

When the vines are established and heads are formed I propose to graft the choice varieties by the approach method.

SOME OBSERVATIONS ON AGRICULTURAL WORK IN EGYPT, AMERICA, AND JAPAN.

III. JAPAN.

BY

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Professor of Agriculture, Agricultural College, Lyallpur, Punjab.

(Concluded from page 280, vol. XIII, pt. II.)

I SPENT twenty-four days in Japan and confined my enquiries to the subjects of—

(*a*) agricultural education; and

(*b*) introduction of agricultural improvements.

AGRICULTURAL EDUCATION.

A great deal seemed to be going on in agricultural education, especially in technical and elementary schools. Agricultural education is in charge of the Department of Education in Japan.

Imperial University of Tokio. This has six Colleges or Faculties, *viz.*, Law, Medicine, Science, Engineering, Literature, and Agriculture; the latter has 33 professorial chairs and over 700 students in all. There are also 27 post-graduate students.

The university is well equipped and has attached to it an experimental farm together with a students' farm and a demonstration farm which seem to be very well managed. The average age of pupils entering universities in Japan is high, *viz.*, 23½ years. This is due to the long series of schools through which a pupil must pass before he can be admitted to the university. The course at Tokio lasts three years. The number of regular students is 452 with 286 pupils in addition undergoing special courses. A similar

Agricultural Faculty is attached to the Hokkaido University, but on a smaller scale. The undergraduate instruction is briefly as follows :—

Technical institutes. These are the lowest grade and take pupils who have finished the compulsory elementary education of six years. The number of pupils in these in 1908 was 163,300. The number of these schools now is over 5,000. In this connection I may note, some kind of technical subject is compulsory in the higher elementary schools. Three subjects are given, *viz.*, agriculture, manual training, and commerce, of which one or more is compulsory. The following table taken from the "Outlines of Agriculture in Japan," published by the Agricultural Bureau, indicates the system concisely :—

Educational organs of agriculture.

Jurisdiction	High educational organs		Ordinary organs		Organs for agricultural training
	University	Higher Technical School	A Class	B Class	
Department of Education	Agricultural College of University	Practical course of Agricultural College of University Higher Agriculture and Forestry School Higher Sericultural School Higher Horticultural School Training Institute of Agricultural Instructors	Agricultural School Stock farming School Horticultural School Sericultural School	Agricultural School Sericultural School	Agricultural supplementary School

Higher agricultural technical schools. These take graduates of the middle school or those equally qualified. The higher technical schools give a three-year course and turn out men qualified to teach in the middle schools and primary schools. In this class we may reckon the practical courses given at the Universities of Tokio and Hokkaido.

Agricultural schools. For these, pupils who have gone through the six years' compulsory primary course and have subsequently done two years' study in higher primary schools are admitted. The course in these schools extends over three or four years. Each

prefecture has one agricultural school of Class A, while many counties and towns have Class B agricultural school. I visited twelve of the various types of agricultural schools. The education is very general in all of them with agriculture occupying from two to six hours a week according to the class of school. The agricultural training is practical in all the middle and higher schools. I give below the time-table of the Shizuoka Agricultural School, course three years:—

First year	Hours	Second year	Hours	Third year	Hours
Morals ...	1	Algebra ...	2	Morals ...	1
English ...	2	Zoology ...	1	Algebra ...	1
Algebra ...	2	L. Language ...	1	Economics ...	2
Botany ...	2	Chemistry	2	Chemistry ...	1
Japan L. ...	2	Physics ...	1	Pathology ...	1
Veg. culture ...	3	Morals ...	1	Gymnastics ...	1
Chemistry ...	2	Veg. culture ...	1	Sericulture ...	2
Chinese classics ...	1	Special veg. culture ...	2	Drawing ...	1
History of Japan ...	1	Chinese classics ...	1	F. Language ...	2
Sericulture ...	2	Manure ...	1	C. feeding ...	2
Zoology ...	2	English ...	2	Veg. culture ...	1
Mathematics ...	2	Sericulture ...	1	Forestry ...	2
Drawing ...	1	Drawing ...	1	Japan Lan. ...	3
Gymnastics	2	Insects ...	1	Surveying ...	1
Physics ...	1	Germs ...	2	Fruits ...	1
Entomology ...	1	Plant disease ...	1	Physics ...	1
Geology ...	1	Cattle feeding ...	2	Manure ...	1
Geography ...	1	Geography ...	1	Chemistology ...	1
Writing ...	1	Botany ...	1	Geometry ...	2
	30	Soils ...	1	Agri. law ...	1
		Forestry ...	1	Technical agri. ...	1
		History ...	1	Marketing of agricultural products	1
		Gymnastics ...	2		30
			30		

The course here is typical of most of the middle and higher grade agricultural schools. The subsequent career of graduates is given below:—

Shizuoka Agricultural School.

Graduates	588
At home	316
Government office	63
Various schools	76
Agricultural Society	19
Under counting or prefecture experimental station	21
To banks and other commercial houses	10
To higher agricultural school	19
Military service	34
In foreign countries	14
Dead	16

One of the best agricultural schools I saw was at Kyoto.

To bring out clearly the relation of agricultural education to general education I give below the ordinary school courses in Japan :—

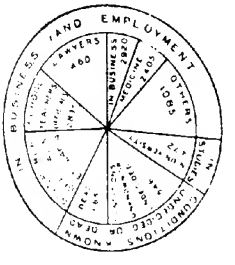
General education.	*Agricultural education.*
(1) Six years' compulsory elementary education	None.
(2) Two years' optional elementary education	Candidates who take this, have choice of 3 subjects, *viz.*, commerce, manual training or agriculture, one of which must be taken.
(3) Middle school course, 5 years	Agricultural schools of Class B and Class A. These are of 3 or 4 years' duration and *do not lead* to University.
(4) Higher and technical schools, 3 years	About 12 agricultural schools of this class exist. Similar technical courses exist in the University.
(5) University	Agricultural College.

It will be noticed from above that the elementary agricultural education tends to draw men from the regular road to the university. Thus the middle school course in agriculture is for boys of 14 or 15 to 18 years old and the bulk of them naturally go to their homes afterwards and do not look for appointments.

The inclusion of agriculture with three optional subjects in the two years' (optional) elementary education is also significant.

From the list of graduates of the Shizuoka School given above it will be seen that by far the greater number return to their homes. This was a school I would class as "Class A Middle School" and was a Prefecture School.

As to graduates of the higher technical schools, a great number of them go to appointments as teachers in lower schools and the education is so general that they are fit for any post in the lower schools.



I give here a diagram taken from the report of the Department of Education for 1914 as to careers of graduates of Tokio, Kyoto, Tohoku and Kyushu Imperial Universities (also including graduates of the old Sapporo Agriculture School).

The course to get through the university is so prolonged that comparatively few can afford to go through it. A great deal of

agitation was going on with a view to reducing the number of years in the full course (19 at present).

The number of students taking university courses in agriculture (400 regular and over 300 special courses at Tokio) does not seem high for a population of 70 millions and for a country with large undeveloped tracts in Hokkaido, Formosa, Chosen, etc.

To grasp the length of the educational course in Japan one may imagine a boy of six years starting school. He finishes compulsory education at 12 or 13. Then follows two years' further elementary course, five years' middle school which brings him to 19 or 20 years old, and then perhaps three years technical or higher grade school before he enters the university. English is compulsory in all schools above compulsory elementary schools. Discipline is invariably excellent. Great stress is laid on loyalty. Drill and military training is a feature of all higher schools. The wearing of a distinctive uniform is very general in schools in Japan. The development of agricultural schools has been very rapid and in consequence many of the teachers are not well qualified, but on the whole I was much impressed with the headmen in all the schools visited.

In the short time at my disposal it was impossible to go into every detail, but the above is sufficient to show the great importance attached to elementary training in agriculture, a branch in which India at present is gravely behindhand. In America also a great deal was being done in elementary agricultural education, but I had no time to see any schools. I saw Texas and California State Colleges: they were doing good work and have courses very similar to our vernacular courses, besides the ordinary degree classes.

Agricultural improvement.

A great deal of work is in progress in Japan on rice—mainly varietal work. Some thousands of varieties seem to be grown and the subject is a difficult one. It seemed to me to be tackled on sound lines in most places.

Reorganization of holdings. Here is the most conspicuous success of this nature I came across. Already over 10 per cent.

of rice land has been readjusted into regular and compact holdings. To secure readjustment a majority of the farmers in any tract must be in favour. Formerly two-thirds majority was necessary, but the benefits were so soon realized that at present only a bare majority is required. Various bounties are given and certain remissions of land revenue to encourage the practice. A good deal of proselytizing goes on also and a persistent campaign is conducted in favour of it.

VETERINARY RESEARCH: SOME RECENT CONTRIBUTIONS.

EPIZOOTIC LYMPHANGITIS.

BOQUET, NÈGRE, AND ROIG.—FIRST ATTEMPTS TO PREPARE A VACCINE AGAINST EPIZOOTIC LYMPHANGITIS. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

Hitherto it has not been possible to prepare a vaccine against epizootic lymphangitis because it has not been possible to obtain cultures of the parasite in series. The authors have obtained some cultures from Rivolta which have enabled them to make some experiments in this connection.

They have ascertained that animals that have been affected for a period of fifteen days or have recovered from the disease yield a serum that is rich in antibodies, and further that recovery from natural or experimental infection confers immunity.

It has also been observed during the treatment of the disease with sterilized cultures of the parasite that in the benign form the disease is checked after the fourth injection. The authors have, therefore, been led to try heated cultures as a vaccine.

For the preparation of the vaccine the growth obtained on the surface of Sabouraud's medium was first ground up in a mortar dry and then emulsified with salt solution, the salt solution being added in the proportion of about 30 c.c. to 20 cg. of culture.

The vaccine so prepared was sealed up in tubes and heated to 62°—64°C. for an hour.

Four injections of 5 c.c. each were given subcutaneously on the side of the neck at intervals of eight days.

Four horses were inoculated in the manner described without producing any lesions beyond a slight transitory swelling. Eight

days later two of the animals were inoculated subcutaneously with 4 c.c. of emulsion of culture which had not been subjected to heat; after a period of incubation of four to six weeks there developed in these animals either a generalized lymphangitis or a localized lesion at the point of inoculation.

No healthy horses were available to use as controls, but two rabbits were inoculated with the same culture as the authors had previously found that inoculation of rabbits leads to the formation of a local lesion.

The two horses vaccinated but not inoculated with living culture were kept under observation for three months without showing any symptoms of infection. It is, therefore, concluded that heated cultures can be injected with perfect safety.

Of the two horses which received both vaccine and culture one developed a sterile abscess at the seat of inoculation, and at the seat of inoculation in the other there developed a small nodule about the size of a pea, which disappeared eventually.

Both of the control rabbits developed abscesses in which cryptococci could be found, thus proving that the cultures had not lost their vitality or pathogenicity.

All the vaccinated animals were mixed haphazard with seriously affected animals, yet none of them contracted the disease.

The authors state that they do not draw any definite conclusions from their experiment, but state that it does indicate the possibility of inoculating against the disease with sterilized cultures, and that the investigation will be repeated.

NÈGRE, BOQUET, AND ROIG.—THE MYCOTHERAPY OF EPIZOOTIC LYMPHANGITIS. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

In this paper the authors record their first attempts at treating cases of epizootic lymphangitis with vaccines prepared from artificial cultures which they have been able to obtain of the organism.

The vaccine was prepared in the same way as has been already referred to in another abstract dealing with the same subject taken from the same journal.

The vaccine was injected at intervals of eight days, and th initial dose was 2 c.c. The successive doses were increased by 1 c.c. up to a maximum of 5 c.c. which dose was not exceeded.

The injections were made on the side of the neck and th horses treated were not subjected to any other treatment; abscesses were not even evacuated.

In all, fourteen horses were submitted to treatment, but of these four could not be given the full treatment owing to difficulties of communication.

Of the ten animals which received the full course of treatment, eight made complete recoveries, while the remaining two which were the subject of severe disease of long standing died of intercurrent disease during the treatment.

A detailed statement of the ten cases is given, and these are divided into two groups according to whether there was cording of the lymphatics or not.

From the description of the detailed cases it would appear that in practically every case the injections of the killed vaccine caused abscess formation, and that recovery resulted in from one to three and a half months.

In a summary of the immediate results of the inoculations it is stated that during the first 24 hours there develops at the seat of inoculation a hot painful swelling about the size of the palm of the hand or a little larger. This swelling disappears in three or four days, but the area is still painful for several days longer. There is also a febrile reaction on the day following the injection, which lasts for two or three days.

NÉGRE AND BOQUET.—THE CULTIVATION IN SERIES AND THE DEVELOPMENT OF THE PARASITE OF EPIZOOTIC LYMPHANGITIS. *Ann. Inst. Past.*, Vol. XXXII, No. 5, May, 1918.

This long paper does not lend itself easily to summarization in a brief manner; a translation of the general conclusions drawn by the authors is, therefore, given :—

Pus containing cryptococci, taken aseptically from an unruptured bud and sown out upon an agar medium made from

horse dung and covered with a maceration of equine gland tissue, yields visible colonies which can be transplanted upon the same medium or upon Sabouraud's agar at first with and subsequently without the gland maceration. (Details of the preparation of the dung agar and the gland maceration are given in the body of the paper.)

With successive subcultures the cultivation of the parasite becomes more easy, and it develops more rapidly. After a number of passages it can be transplanted on to various media containing agar, gelatine, potato and carrot.

The optimum temperature for cultivation is 37°C. At this temperature the colonies upon Sabouraud's agar have a sandy yellow colour. They are wrinkled, and scattered over them are a number of little downy white spots. This downy appearance is more pronounced at lower temperatures.

When first sown out the cryptococcus becomes swollen and rounded, and drops of oil make their appearance in its interior. It then develops double contoured mycelial threads which produce external spores.

In subsequent subcultures the young colonies are composed of septate mycelial tubes with thin walls.

In older colonies these filaments disappear after having produced external spores by a process of budding. The latter give rise to septate mycelial tubes with a double contour and to chlamydospores. They are identical with those which arise by a process of budding from the rounded forms of the cryptococci.

The rounded form of the parasite as it occurs in primary cultures and the external spore are therefore the points of origin of exactly similar thread formations, and it would appear that the cryptococcus is the form of multiplication within the body which corresponds to the external spore.

We have established the fact that the parasite is able to multiply in the horse's skin in the form of the threads referred to above—that is to say, as tubes showing a double contour and external spores. According to one of our observations, which requires confirmation, the cryptococcus is developed in the horse's skin by a process of

budding from the external spore. At the moment when budding takes place the spore has only a thin wall.

In old cultures the segments of the mycelial tubes become detached from each other and have a twisted appearance.

Horses inoculated by scarification or intra-dermally with cultures of the parasite develop abscesses containing the cryptococcus. Subcutaneous inoculation results in the formation of abscesses which may subsequently become generalized by way of the lymphatics, thus producing the clinical picture of the natural disease.

Cryptococci appear in the lesions from three to four weeks after inoculation. They are at first free and appear as small ovoid bodies with thin walls. They then acquire a double contour, and the majority of them are to be found within the leucocytes.

The serum of diseased animals gives a positive result by the fixation test with cultures of the parasite. Antibodies can be shown to be present in the blood about the twentieth day after the disease makes its appearance. They persist for a long time after recovery.

A horse which has recovered from a primary attack of lymphangitis is resistant to a second inoculation with culture.

To sum up, we have succeeded in obtaining the development of the cryptococcus in the mycelial form. We have been able to obtain cultures of the organism in series.

We have established the multiplication of the parasites in the horse's skin in exactly the same form as in cultures.

We have reproduced the disease experimentally by inoculation with cultures and have shown that the cryptococcus makes its appearance and develops in the lesions produced.

We therefore think that the cryptococcus is the multiplication form within the horse's body of the organism which we have described.

The parasite will only be able to be classified when its sexual method of reproduction is accurately known.

RINDERPEST.

YOUNGBERG.—THE IMMUNITY TO RINDERPEST OF NELLORE (INDIAN) CATTLE AND OF VARIOUS NELLORE-NATIVE GRADES. *Philippine Agricultural Review*, Vol. X, No. 4, 1917. (Ex. *Trop. Vet. Bull.*, Vol. VI, No. 2, 1918. Original not available.)

It has been found that Nellore cattle adapt themselves readily to the conditions in the lower altitudes of the Philippine Islands and that when crossed with Native or Chinese dams a good type of animal is produced.

The idea was prevalent among Philippine breeders that the immunity possessed by Indian plains cattle to rinderpest could be transmitted to half-bred progeny. The author produces evidence both from field and experimental sources which shows that this is not the case.

The following conclusions are drawn up :—

(1) The pure Nellore cattle are very highly resistant to the Philippine strains of rinderpest, the mortality being insignificant. They are not, however, absolutely immune.

(2) In the case of Native cattle the infectivity of the virus is not appreciably attenuated by being passed through Nellore cattle. This fact makes the latter very dangerous as conveyors of disease, as they may react without showing clinical evidence.

(3) The half-bred Nellore cattle do not inherit the high degree of resistance to rinderpest possessed by the Nellore stock. In infections of moderate virulence they apparently have somewhat more resistance than the Native animals, but in virulent infections this resistance does not afford them any protection.

(4) From the inconclusive evidence at hand, the three-fourths Nellore-Native grades appear to have a greater resistance than the Native stock.

(5) The rinderpest problem of the Philippine Islands cannot be solved by the importation of Nellore or other Indian cattle unless possibly by carrying it out to the extent of practically eliminating the Native stock.

PARASITOLOGY.

CHATTON.—MICROFILARIA OF THE DOMESTIC CATS IN SOUTHERN TUNIS. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

The parasite figured and described in this note was found in two out of twenty-six cats examined.

In one of these they were scantily present in the blood at post-mortem, and in the other fairly numerous.

There is no information as to whether the parasite is present periodically in the blood.

The parasite appeared to be devoid of any sheath. In preparations fixed with osmic acid, it ranged from 240 to 350 microns in length, and from 7 to 9 microns in thickness. In view of the fact that the longer parasites were thinner than the short ones, it would appear that the differences in thickness were accounted for by contractions. The anterior end was obtuse and the posterior very slender.

There was no discoverable striation of the cuticle. The author thinks that the parasite bears some resemblance to *Filaria imitis* which is known to occur in Tunis.

YAKIMOW, SCHOCHOS, KOSELKINE, WINOGRADOW, DEMIDOW.—MICROFILARIASIS OF HORSES IN TURKESTAN. *Zeitschr. f. Infektions Krankh. etc. d. Haustiere*, Vol. XVI, No. 4. 1915. (Ex. *Trop. Vet. Bulletin*, Vol. VI, No. 2, June, 1918. Original not available.)

Examination of horses in military and civil possession in Turkestan showed that the former were far more severely affected than the latter. The maximum percentage infected in military units was 37·6. The maximum discovered among civil horses was 8·1.

The symptoms presented were abrasions of the skin due to irritation, especially about the nostrils, œdematous swellings of the chest, abdomen and limbs, and in some cases rapid exhaustion and dyspnœa when the animals were put to work.

The hæmoglobin content of the blood fell to 60 per cent. There was very marked eosinophilia, lymphocytes were increased in numbers and polynuclear leucocytes showed a corresponding decrease.

The filariæ possessed a sheath which projected beyond both ends of the body.

The body of the parasite, which was rounded anteriorly and tapered posteriorly, measured from 159 to 267 microns; while the total length of the sheath ranged from 270 to 323 microns.

No diurnal periodicity was observed, and subcutaneous inoculations of infected blood into a horse, ass, and two sheep failed to produce infection.

Intravenous injections of salvarsan were without effect.

The authors believe that this parasite differs from those previously described as occurring in horses and suggest the name *Microfilaria ninæ kohl-yakimovi* for it.

MOUCHET.—SOME ANATOMICAL LESIONS PRODUCED BY NEMATODES. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

The author describes in this paper some lesions which he found in the organs of a leopard which had been poisoned with strychnine on account of the depredations it caused among goats at Kangomba (Tanganyka).

The whole of the intestinal wall starting from a point 20 centimetres from the stomach to a point 30 centimetres from the cæcum was scattered with nodules which numbered about a hundred. They projected from beneath the serus membrane, were about the size of peas, and were of a bluish colour. The nodules were cystic and the walls were from two to three millimetres in thickness. Inspection of the mucous membrane showed that the cavities of the cysts communicated with the lumen of the intestine by small openings about one millimetre in diameter. Each of the cysts contained several worms from one to two centimetres in length. A small number of the cysts appeared to have no orifice leading into

their intestines, this was particularly the case with the smallest of them.

The worms were identified by Railliet as *Galoncus perniciosus*.

VAN SACEGHEM.—GASTRODISCUS ÆGYPTIACUS (COBBOLD, 1876). *Bull. Soc. Path. Exot.*, Vol. XI, No. 5, May, 1918.

Although the author's observations are incomplete owing to his having been compelled to leave Zambi where he was working, he gives the results of some of his investigations.

The eggs of *Gastrodiscus ægyptiacus* are easily discoverable in fresh fæces of infected animals. They measure 150 to 170 microns in length by 90 to 95 microns in width.

Apart from a polyhedral shaped mass in the centre the eggs show no evidence of segmentation at the time of laying. After three weeks' exposure to a temperature of about 28°C. (the average temperature of the laboratory) the contents of the eggs become very granular.

Segmentation takes place whether the eggs are kept in a liquid medium or not. After some days a little vermicule is visible in the egg. This executes intermittent movements and is ciliated.

The miracidium having escaped from the egg maintains its vitality and executes rapid movements if the escape takes place in water. If moisture is not present it rapidly dies. The larva measures about 160 microns in length by 73 microns in width. The anterior extremity is rounded and not pointed as in the case of the miracidium of *Fasciola hepatica*. In view of the facts that enormous numbers of horses harbour this parasite in very large numbers, and that a country very rapidly becomes infected with the parasite, the natural conclusion is that the intermediate host of the parasite, if one is necessary, must be an extremely commonly occurring one. The author thinks it is probably a common mollusc.

The parasite is, as a rule, not responsible for serious disturbances of health, but it may assist in producing ill health in animals in poor condition.

Infected horses not infrequently suffer from colic, and the author has found tincture of opium with the addition of ether the best treatment for this.

Arsenic appears to be valueless for the expulsion of this worm.

The only prophylactic measure that can be adopted is to prevent horses drinking on marshy ground and feeding grasses cut in marshy places.

VAN SACEGHEM.—THE CAUSE AND TREATMENT OF GRANULAR DERMATITIS. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

According to the author of this paper the cause of summer sores is the larva of *Habronema muscæ*.

Some larvæ of *Musca domestica*, which had been bred in the laboratory, were placed in the dung of a horse known to be infected with *Habronema muscæ*.

Seventy per cent. of the flies which developed from these larvæ were found to be infected with the larvæ of *Habronema muscæ*.

This infection takes place during the larval stage, but not during the nymphal stage.

The larvæ of *Habronema* are capable of surviving for 12 hours in a liquid medium. If they are placed on the hair, or on a shaved area of skin of a horse, they show no tendency to pierce the skin, but if placed on lesions covered with serum they show a great tendency to penetrate.

The author has observed small parasitic nodules on the membrana nictitans and has produced the same lesions experimentally.

Treatment is both prophylactic and curative.

The administration of arsenic in doses of 1 to 2 grammes daily should, in the author's opinion, be beneficial in destroying the larvæ in the horse's stomach.

Since the larvæ are rapidly destroyed in manure heaps which are generating a good deal of heat, it is possible to reduce the chances of infection by burying the fresh dung daily in a fermenting heap.

By this means both the larvæ of the worms and of the flies which are likely to become parasitized may be killed.

During the hot weather all wounds should be dressed with dry powder dressings.

As a curative dressing for wounds already infected, the author advises a powder composed of "plaster" 100, alum 20, naphthaline 10, quinine 10 or some other bitter powder. Such a powder keeps off flies, is very adherent, causes rapid drying of the wound, and on account of its bitter taste prevents the animal from biting itself.

TRYPANOSOMIASIS.

SERGENT Ed. AND ET., FOLEY AND LHÉRITIER.—THE MORTALITY IN EL DEBAB TRYPANOSOMIASIS OF THE DROMEDARY. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

According to Algerian camelmen El Debab in the dromedary runs a course ranging from some months to several years, and usually terminates fatally.

The authors have had under observation a couple of naturally infected animals. Both died four months after infection.

An experimentally infected dromedary appeared to have made a complete recovery after one and a half months.

It is pointed out that bad management is not infrequently a predisposing cause of death among infected animals. On the other hand, the absence of clinical symptoms often leads to the death of animals being attributed to bad management, whereas they are in reality infected with trypanosomes.

About 10 per cent. of Algerian dromedaries are infected.

VELU.—OCULAR AND LOCOMOTOR DISTURBANCES IN EQUINE TRYPANOSOMIASIS IN MOROCCO. *Bull. Soc. Path. Exot.*, Vol. XI, No. 7, July, 1918.

Lesions of the eye, while fairly constantly observed, have not the same importance as the disturbance of the locomotor apparatus.

The conjunctiva may be distinctly yellow, but this is sometimes masked by congestion. Petechiæ of various sizes are present. These are at first red in colour but subsequently acquire a purple tint.

The eyelids are œdematous and the eyes half-closed. There may be erosion of the conjunctiva associated with profuse lachrymation.

These lesions may be present in varying degrees of severity. The locomotor disturbances are by far more constant, but these also vary in severity from case to case. They range from mere weakness, which is usually more pronounced in the hind limbs, to actual paralysis.

On a number of occasions the author has observed complete inco-ordination during febrile attacks. In every case in which locomotor disturbances have been pronounced, there has been incontinence of urine.

MISCELLANEOUS.

McCULLOCH.—THE STABILITY OF AN ALKALINE HYPOCHLORITE SOLUTION. *Jl. R. A. M. C.*, Vol. XXX, No. 5, May, 1918.

The experiments detailed by the author of this short paper were carried out with the object of ascertaining the value of an alkaline hypochlorite solution as a sterilizing agent—such a solution having been put on the market as an efficient water sterilizer. The experiments were carried out at Wellington, India. The author concludes that a solution containing calcium hydroxide, calcium hypochlorite, and sodium hypochlorite, with an average amount of available chlorine of 3·5 per cent., of which 0·35 per cent. was in the free state, is not much more stable than bleaching powder and is of little value as a stable sterilizer in tropical countries.

Selected Articles.

SILK AND SILKWORMS IN THE FAR EAST.

Being information gathered during a recent visit to China, Japan, Korea, Manchuria, and French Indo-China.

BY

COMMISSIONER AND MRS. BOOTH-TUCKER.

I. South China.

Canton. The Canton variety of silkworm is a multivoltine, producing crop after crop in quick succession all round the year. It is closely related to the Mysore silkworm, and produces small cocoons but with a very good quality of silk. The cocoon is not worth exporting, except in the case of pierced cocoons which are exported as waste silk. The price when we were at Canton averaged about 83 dollars per picul of 133 lb.

In regard to colour of cocoons and silk, this varies. There are some which are the same light greenish colour as the Mysore and others which have the rich yellow of the Bengal, but the bulk are pure white, and only the last mentioned are used for producing reeled silk for export.

There are large filatures engaged in reeling this silk which is eagerly bought up by foreign merchants.

A very large proportion, however, of the cocoons are reeled and made into silk fabrics in China.

There are a number of small weaveries in Canton working with Chinese handlooms of a very ancient pattern. The work turned out is, however, excellent.

It was noteworthy that a great deal of the raw silk is put on the looms without being bleached, the fabrics being bleached afterwards. On the other hand, a good deal of the raw silk is bleached before being put on the looms.

On some of these old-fashioned looms patterns of beautiful design are worked by means of a very ingenious "Jacquard" arrangement, if so it may be called, a weaver sitting above the loom and pulling an intricate number of threads to work the healds. No arrangement appears to have been made in Canton for introducing the much more simple Jacquard attachments, although the present plant certainly produces very satisfactory results.

The Silk Expert who kindly assisted us in our enquiries and who had had eight years' experience in the country, told us that he did not know of any school in South China for the instruction of the Chinese in superior methods of either rearing worms, reeling silk, or weaving, but the industry is so extremely ancient and the Cantonese are so very painstaking and careful in attending to details, that the whole industry is carried on with great success both as a cottage industry and otherwise. Recently, however, large filatures have been organized on the European model, and these appear to be very prosperous.

II. North China.

We visited Shanghai, Pekin, and Mukden, and made enquiries at various centres. Here we found three excellent varieties of cocoons, namely, Wusih, Shewshing and Hupeh. Experts whom we consulted told us that, in their opinion, the Wusih and Shewshing, which are white cocoons, are superior in quality to the Italian.

The extreme care and attention which is given by the Chinese to the cultivation of their silkworms, and the long period that the industry has existed will account for its great success. Government is now taking considerable trouble to establish silk schools in different parts of the country, so that improved methods may be introduced.

We were able to get a supply of Wusih and Shewshing eggs forwarded to us and have hibernated them in Simla and are sending them out to various centres throughout India, as well as to all Government institutions with which we are acquainted. This we are doing free of charge although the experiment has cost us a good deal, as we are satisfied that one, if not both, of these varieties,

may be of extreme value to us in India and may be better suited to the climate than either the French or Italian varieties. We have asked the different centres to which the eggs are being sent to kindly report the result. The North China cocoon harvest is in June and July in the hot weather, and hence it is probable that this kind of silkworm would be well suited to India.

The North China silkworms are univoltine and the cocoons, as in the case of other univoltines, are far superior to the multivoltines of South China.

We may here remark that the univoltine variety has one great advantage over the multivoltine, inasmuch as its care does not interfere with the growing of the ordinary crops. It is usually produced at a time when agricultural labour is, comparatively speaking, free, and helps to supplement the revenue from other crops without interfering with them.

In making investigations on this question in France and Italy, experts there said to us that they did not care to introduce multivoltine varieties into Europe because it was found that they interfered with other and more profitable crops, which was not the case with the univoltine. This is a point which should be borne in mind. The agriculturist naturally looks for profit and the introduction of a crop which pays better than silk has been known in some localities to lead to a wholesale destruction of mulberry trees, as was the case some years ago in parts of Italy.

There is an immense demand for the above three kinds of cocoons in the Chinese filatures and high rates prevail so that the cultivation is extremely profitable to the people. The Yang-tse-Kiang river forms a splendid highway for their transportation to the filatures on the coast, and this, in the absence of railways, helps in the production.

Both the Shewshing and Wusihs are pure white cocoons, while the Hupehs are a rich golden yellow. The Hupehs appear only to have been recently introduced to the filatures and were at first looked upon as inferior. In fact reelers in some of the filatures refused to use them, showing how strong is the feeling in China in favour of white cocoons as opposed to yellow. It was necessary

n some of the filatures to begin with two or three basins and gradually work up others.

The Wusihs are produced in a flat level country very like Bengal r the Gangetic valleys, the summer heat being very great. The Shewshings are produced in a somewhat hilly country at an elevaion of about one thousand feet. The Hupehs come from the nterior of China.

The mulberry is mostly planted in the form of dwarf trees two r three feet high, planted very close. Lately bushes have been ntroduced, but as a rule only one or two stems are allowed to grow, nd these are cut down yearly. The leaves are stripped off and ed separately, and the worms are reared on large round trays. The ustom for cocoonage, *viz.*, for the mounting of the silkworms to produce cocoons, is to place bundles of grass, tied at the bottom with heir heads spread out. Women gather the worms in baskets when hey appear to be ripe and go round placing them on the top of the bundles of grass to spin. The method is somewhat primitive, but nswers its purpose.

Another plan is to have a long straight rope with flat stars nserted at intervals on which the worms are cast to spin. They re not encouraged to "mount" of their own accord.

The Chamber of Commerce and the French Consulate in Shanghai are endeavouring to introduce improved methods amongst the rearers.

The filatures are quite up-to-date, and the basins which we saw had five, six, and even eight buttons working. Women are mostly employed in doing the reeling, while men supervise and watch the work.

It is not found necessary to re-reel, as the reeling itself is extremely good. In a filature which we visited we were told that all the raw silk they produced was marked as 100 tavelle, that is, without any breaks, while the variation in denier was merely fractional. At the time of our visit this raw silk was fetching 7 American dollars per pound (not kilo.), equivalent to Rs. 21 per lb.

Where large numbers of buttons are worked, the cocoons are prepared for the reelers by girls and the breaks are mended by

separate women who are employed for the purpose. It is a little remarkable that they are paid by the day and not by results. If, however, they do not produce a fair day's work, they are fined. Owing to the high price of raw silk and the strong demand for it, the number of filatures has enormously increased of late.

The godowns for storing cocoons which we visited were nothing like so up-to-date as those which we visited in Srinagar. They are a good deal troubled with rats in the godowns, but rely on cats and traps for keeping these down—they are not able to use poison. The raw silk was packed with extreme care and not in the apparently rough and ready manner which prevails in Kashmir.

Silk-weaving in Pekin. We visited a very interesting weavery in Pekin which was much more up-to-date than the weaveries of Canton. They had imported Jacquard attachments for their hand-looms from Japan, and these were being very successfully worked, many excellent fabrics being produced.

Everywhere, both in South and North China, one could not help being impressed with the fact that the enormous production of cocoons in the country facilitated the manufacture of cheap silk fabrics, and that in this respect India could not hope to compete with either China or Japan till she had established a sufficient production of cocoons. The success of the industry was based on the existence of the raw material.

III. Manchuria.

Manchurian tussor. Authorities claim that the cultivation of the Manchurian tussor preceded that of the domestic variety. The rearing area which originally occupied the Peninsulas of Liaotung and Shantung gradually spread eastward to the valley of the Yalu, Chefoo and Antung, being now the principal commercial centres.

Operations were considerably interrupted by the Chino-Japanese and Russo-Japanese wars. But since their conclusion the industry has advanced with extreme rapidity.

This variety of tussor feeds on four kinds of silkworm oak. The system of growing these in dwarf plantations appears to

well worth considering for application to the Indian tussor nd muga.

The trees are planted by the Chinese about 3 to 5 feet apart, bout 12,000 acorns being planted to the acre. Holes are dug about ″ to 1′ deep and several acorns are placed in each. They are not anured. They sprout in spring, and the weaker growths are then emoved. After two or three years there is a fair growth, and they re then cut back usually to the height of a foot and are used for eeding the following spring. The trees are never permitted to xceed 5 or 6 feet in height.

There are two methods of pruning adopted :

1. The umbrella method, in which the tree is pruned to a eight of two or three feet above the ground in the shape of an mbrella.

2. The tree is cut down at about one inch from the roots, ending out new shoots with dense foliage the following spring.

The pruning is carried out after the gathering of the autumn rop.

A well regulated plantation will include trees of various ages, he youngest or recently pruned being reserved for young worms, nd those with more mature foliage for older worms.

The trees have to be renewed from time to time as the leaves ecome small, hard and unsuitable for feeding.

In the new districts trees are propagated by cuttings rather han seeds. Branches are selected from a growing tree, about 1″ n thickness and 3′ in length. Late in the autumn these are inserted n the ground to a depth of 9″. They sprout in the following spring, nd 3 or 4 worms can be reared on them, the number being increased o 12 and 20 in the following two years.

The droppings from the worms manure the trees and increase he supply of leaf.

The dwarf plantation has the great advantage that the worms an more easily be removed from tree to tree, and protected from heir bird and insect enemies.

There are two crops, of which the autumn one is the best.

There are several systems followed for hatching the eggs.

1. Indoors, the young worms not being taken out to the oak plantation until after the first moult.

2. After separation from the male moths, the females are taken to the plantation and tied to the branches of the trees till they deposit their eggs.

3. In Japan the eggs are kept in a box, and about ten days before hatching are pasted with starch to egg cards, each of which bears about 60 eggs. These cards are then fastened to the trees and the paste prevents the eggs being washed off by rain.

When the eggs are hatched on the first system indoors, the young worms are fed on young branches of oak, two or three feet long, tied in a bundle and placed in vessels containing water, care being taken to prevent them from descending into the water and being drowned. This method is termed the "Han Tun."

Another plan is known as the "Shui Chang" or water yard. Branches are similarly cut and placed in the mud or sand on the banks of a mountain stream. In both cases care must be taken that the place is sheltered and not too exposed to the wind.

The above details show the extreme attention to detail bestowed by the rearers, both on the growing of the food tree and on the care of the worms, contrasting very strikingly with the careless, slipshod methods prevailing in India, and resulting in the rapid deterioration and destruction of what might become a valuable asset in her commercial, agricultural, and industrial prosperity.

For further information on this subject, see Norman Shaw "Manchurian Tussor Silk," Fauvel's "Silkworms of Shantung" and Palen's "Wild Silkworm Culture in Manchuria."

At the same time it has to be remembered that the tussor silkworm cannot as a rule be compared from a commercial and profitable standpoint with the domesticated varieties, and it would be our judgment be a mistake to concentrate attention upon it at the present stage of the silkworm rearing industry in India.

The thread of the tussor is flat, making it difficult to combine with other fibres, while that of the domesticated *Bombyx* is round. It also lacks in brilliancy. The market likes it mainly if and when it can be obtained cheaply, and often, as in the case of the eri,

"waste" rates, which may not pay to produce, and which cannot ordinarily compare with the prices commanded by mulberry silk.

IV. Japan and Korea.

In Japan we were very kindly received by Prof. Honda, President of the Imperial Sericultural Institute, who gave us much valuable information regarding the industry in Japan. This college has a staff of about 40 professors and teachers and is extremely well organized. Professor Honda himself has written a most excellent treatise on silk in Japan, containing a quantity of information which should be very valuable for use in India. We have supplied this book to our silk schools.

There is no doubt that the organization of the silk industry in Japan is far ahead of that in any other country. The Japanese are born organizers, and one has only to travel through their country to see with what care they collect the most exact details calculated to contribute to the success of the industry, and how lavish they are in their expenditure in doing for silk what no private individual or organization can do for it.

The college is a commodious building, wooden, inexpensive, very simple, covering nearly the whole ground on which it is located. At the time of our visit there were 200 students. The ordinary course for students covers two or three years, and those who were admitted must have certain educational qualifications.

In spite of the great heat at the time of our visit—it was in July—the worms seemed to be doing well in all stages with the thermometer going up daily to 90° and 95° Fahrenheit. They did not appear to suffer in any way; nor was there any attempt made to keep them cool beyond having them on the ground floor of a double-storied building with ample ventilation, while the leaf was kept in a cool cellar, damped, so as to prevent its losing its juiciness and becoming dry through the heat. The professor told us that all over Japan similar conditions existed, and that the worms there did not suffer from this extreme heat.

He informed us that throughout Japan the worms were fed on bush mulberry, and he did not consider it necessary to have tree

mulberry, but that there were a great many different varieties of mulberry—between two and three hundred in all—and some were far better than others and produced better results. Great care was taken moreover in feeding the young worms on young leaves and the older worms on matured leaves.

In travelling through Japan we noticed the absence of tree mulberry, and that in some cases instead of bush mulberry there were dwarf trees. We noticed also that the greatest care was given to the cultivation of the mulberry plants. The plantations were absolutely weedless, well manured and cultivated, and, in almost all cases, irrigated. Hence, in spite of the great heat there was a full and abundant supply of leaf which seemed juicy and tender. Again, instead of the poorest soil being given to it, as is so often the case in India, so far as we could see, the best and richest soil was being utilized for growing mulberry. Evidently, in the opinion of the Japanese, no soil was too good for the food of the silkworm. We asked the professor whether there was any special reason for preferring bushes to trees. He replied that trees were much more liable to disease, and hence the preference for bushes. It was much easier also to pick the leaves, and the bushes could be planted far more closely than trees.

Grainage. The utmost care is given to grainage, or the production of disease-free eggs. No one may produce eggs without a licence and a staff of something like 3,000 inspectors is employed in inspecting the licensees and watching that no diseased eggs are allowed to be produced. The ordinary rearer of silkworms was forbidden to grow seeds either for himself or for others.

Hibernation. The best way of storing eggs was, in the opinion of the professor, in windhalls, or caves, which were dug in the side of hills. Positions were found in the slope of a hill facing north where there was reason to believe that there would be a natural current of air from inside, and here a *pukka* cave was made about 20 feet in depth right into the side of the hill. It was essential that there should be natural draught, hence the name "windhalls." Coming from inside, it secured a uniform temperature, throughout the hottest weather, of from 30° to 40° Fahrenheit. It was built

[illegible] of the hill with some sort of trellised doors so that the wind could [illegible]out freely all the time and play upon the eggs, which were simply [illegible]ged in shelves. Another system of hibernation was the usual [illegible]-pit, while another was the artificial refrigerator. This last [illegible] very complex and expensive and did not appear to be particularly favoured by the professor, though one was in operation in the grounds of the college. He considered the windhalls were the most suitable. In these, eggs could be stored right through the hot weather. This was important as the Japanese have now two harvests of cocoons, one in the summer—the most important—and another in the autumn. The eggs for both are the univoltine variety and are the previous year's layings, being preserved in the windhalls till they are required for use.

This is an extremely important point for India, owing to the fact that in a great part of the country the mulberry produces its best supply of leaves after the south-west monsoon, and the regularity of this monsoon would probably enable a very good crop of cocoons to be produced at this time. At present the attempt to keep the eggs artificially till they are required at the end of the monsoon has not been a success, but the windhalls may get over this difficulty.

On the point of re-reeling, the professor told us that it was the universal practice in Japan to re-reel their raw silk. This was not in order to get the tavelle perfect, but because of the dampness of the climate. It was not necessary in China, and would not be in other places where the climate was not so damp as that of Japan.

In Korea the Japanese have made great efforts for the extension of the silk industry, and the prospects seem excellent. [See Japanese official report on the administration of Chosen (Korea).]

It is important to note that in Japan, from the Emperor's household downwards, the whole country takes an interest in the rearing of silkworms.

The Empress herself has a mulberry garden inside the palace grounds and cultivates silkworms with a view to encouraging the industry.

II. The Government also throws itself heart and soul into the industry—

(*a*) Sericultural Institutes. There are two important institutes supported by Government, one in Tokio and the other in Kioto.

(*b*) Prefectural Schools of Sericulture are also established in four different Prefectures.

(*c*) There are also thirteen Sericultural County Schools, besides many private schools.

(*d*) There are eight Prefectural Institutes of Sericulture and five County Institutes, while private institutes are innumerable, and there are a number of temporary institutes and training places opened during the rearing season.

(*e*) Agricultural Colleges, Forestry Schools, and Agricultural Experiment Stations give training in sericultural courses. These institutions, when not supported by Government, Prefecture, or County, are liberally subsidized by them. Subsidies are also given by Government for enlarging mulberry plantations.

(*f*) Circuit Lecturers are employed by Government, Prefectures, Counties, Towns and Sericultural Associations. They are sent round to give direct guidance and encouragement to those engaged in the industry. Some of these circuit lecturers are employed all the time, while others are only employed for the season. They are supplied from among the graduates of the above mentioned schools and institutes.

(*g*) Competitive Exhibitions. Numerous exhibitions are held in the different parts of the country to give encouragement to sericulturists, by collecting and exhibiting their products, thus giving stimulus for the betterment of the industry. Prizes or certificates of excellence are given. At least 50 such exhibitions are held annually.

(*h*) Precautions against silkworm disease. Special laws are passed and strictly enforced for the prevention of disease. The offices for the prevention of silkworm diseases number 132, while the staff thus employed amounted, in 1909, to 3,175 persons. The annual expense for this one purpose, paid by the Central or

fectural Governments, reached the vast sum of one million , say, 20 lakhs of rupees.

"*Conditioning*" *of raw silk.* Government has established a nditioning house" by special act of legislature in Yokohama. is we visited. No charge is made by Government for condition- the silk, but there is an ingenious arrangement by which this stitution is entirely self-supporting. The actual number of tests rformed in the Silk Conditioning House in 1908 amounted to no s than 97,723.

III. *Sericultural Associations.* In addition to Government pport, numerous Sericultural Associations have been established. e Sericultural Association of Japan has as its honorary president d patron the Crown Prince, with 30 councillors appointed from ongst influential men in the sericultural circle. Its board of in- stigation includes many noted scholars and sericulturists through- t the country, while its membership has reached to 60,000. This sociation has its branches in every Prefecture throughout the untry. Another similar Association exists with a membership of ,000. A third has a membership of 36,000. In addition to this ere are—

67 Sericultural Guilds.
35 Silkworm Egg Guilds.
21 Raw Silk Guilds.
1 Silkworm Rearers' Guild.
2 Silkworm Rearers' and Silkworm Eggs Producers' Guilds.
5 Sericultural Guild Unions.
1 Raw Silk Producers' Guild Union.

Special laws have been enacted to assist these Guilds and have sulted in immense benefit to the members.

IV. *Co-operative Credit Societies.* Under the Co-operative cieties Act passed in 1898, 2,442 co-operative credit societies have en formed for sericultural purposes, being 57 per cent. of the total mber of Industrial Co-operative Societies existing in Japan.

V. *Cultivation of Mulberry.* The total area of mulberry farms Japan was, in 1907, 957,552 acres, being 7·44 per cent. of the total

cultivated lands in Japan and over 16·2 per cent. of the total farm These are steadily increasing year by year. In the Prefecture Gumma 31·5 per cent. of the cultivated lands are devoted t mulberry; in Yamanashi 30·2 per cent.; in twelve Prefecture the percentage ranges from 10 to 31 per cent.; in eleven other from 5 per cent. to 10 per cent.

Nothing is more remarkable than the extreme attention give to details so that a good foundation is laid for the superstructure The methods of mulberry plantation are generally classified unde four heads:—

1. Bush Plantation.
2. Dwarf Plantation.
3. Pollarded trees, similar to France.
4. Full-grown trees.

Each of them is scientifically and methodically adopted and mulberry diseases are carefully dealt with.

V. French Indo-China.

We spent a week in French Indo-China, calling at the ports of Haiphong and Saigon. Saigon is the capital of French Indo-China and we had here the good fortune to obtain advice and information from the Director of Agriculture and Commerce, who is a keen enthusiast upon the subject.

It is extremely interesting to notice the policy pursued by the French Government in French Indo-China, and the changes which have been made by them as a result of their experience.

As might naturally be expected, they commenced by introducing the French univoltine silkworm, but found that in the warm climate of the tropics it suffered considerably. Attempts were made to cross it with the indigenous worm. These again did not prove very satisfactory. Finally Government Experts decided to devote themselves to the improvement of the indigenous polyvoltine silkworm, which is practically the same as the Canton and Mysore varieties. Here they have achieved great success.

They have devoted themselves to two points: one, the provision of disease-free eggs for the people. For this purpose small inexpensive rearing centres have been established in different parts of the country, and the disease-free eggs issued without charge by Government to rearers. No less than 6,272,500 layings of eggs were issued by Government to the rearers in 1914, and the demand for these eggs was double what Government was able to supply.

At the same time Government devoted themselves to the improvement of the indigenous silkworm, not by hybridizing, but by a careful system of selection. It is now a well-established fact amongst silkworm-rearers that the hybridizing of a well-established nationality of silkworms, if one may use the expression, by another nationality of quite distinct origin, is often unsatisfactory besides being extremely tedious. It is a very slow process, extending over many years, and there is a constant tendency to lapse. Where eggs have to be produced by millions, hybridizing can only work very slowly, and whilst there are many excellent breeds of worms in existence, it is doubtful whether commercially the thing is worth much time, trouble or expense. It ought to be done on a small scale for experimental purposes at Government Experimental Stations, but it should not be regarded as part of the Government commercial propaganda, seeing that the market requires large quantities of raw silk of *uniform* texture, not a hodge-podge of many varieties. This is an important point.

The French Government having devoted themselves to improving the existing indigenous worm, they have so far succeeded that the actual quality and length of fibre produced from some of these indigenous worms thus carefully treated, is almost equal to that of the best French varieties. This is undoubtedly a great triumph, but we may say that commercially it does not at present count for much, and it will be many years before it really makes a considerable difference. The fact, however, that this is being done with the indigenous worm and not with a hybridized lapsable variety is very much in its favour, and points very strongly to the policy which ought to be adopted by Government in India.

It must be remembered that all the prejudice of the French experts must have been in favour of their own very superior French silkworms, and that it has been only with reluctance, and gradually that they have altered their policy to suit the tropical conditions of the Orient. The Director has a small silk school under his personal supervision in the Botanical Gardens at Saigon, and very kindly showed us all the details of it. Comparing this school with those of the Salvation Army in India, we could not help feeling gratified to find that it was being carried on along almost exactly the same lines as we had ourselves introduced. The whole object was to encourage sericulture, including reeling and weaving, *as a cottage industry*. There was nothing there which a native could not introduce into his own cottage, and yet every implement used was being improved. There was, for instance, very ingenious, simple, and inexpensive system for the silkworms to "mount" when forming their cocoons. This was to take the place of the ordinary *chandrika*, which is there employed very much as in India. There was also a very simple oven for drying the cocoons, the damp climate of the country making it difficult to do this by means of the sun, as is commonly done in India. The system was also much more satisfactory and quite cheap. The professor preferred the dry heat system to the use of steam. The "bassine à feu vu" for cottage reeling was not in our opinion nearly as good as our own Salvation Army Cottage Reeling Machine, nor was the cottage handloom to be compared with ours.

There was a mulberry garden in which different kinds of Tonkinese and Chinese mulberries were being grown, and careful experiments were being tried.

One of the points on which we made careful enquiry during our visit to the East, including China, Japan and French Indo-China, was the possibility of rearing multivoltine silkworms in tropical climates and in the plains similar to Madras, Bengal, etc., practically all the year round. It was quite evident that the indigenous multivoltine could be thus grown if proper arrangements were made for their food. We came to the conclusion that the success in this respect was largely due to the extreme care given to supplying the worms

with juicy leaves from irrigated mulberries, and that a good many failures in tropical climates are due to the fact that the worms have been badly fed and cared for, and that the proper conditions have not been sufficiently watched, while there has been no attempt anywhere made to cope with disease, which, as is well known, is of an extremely virulent character if not checked at the outset.

SCIENTIFIC PLANT BREEDING.*

So much attention has been directed to the purely scientific advance that has followed the birth of Genetics as a new branch of science that little regard has been paid to the very remarkable results already reached by the application of Mendelian methods to the problems of economic plant production. It is necessary to distinguish somewhat sharply between the facts which Mendel was the first to discover, and the hypotheses which have been put forward to explain these facts. The practical plant breeder is not primarily concerned with the theory of the subject; the Mendelian fact of grand importance to him is that unit characters do segregate, and that new combinations of these characters can be made.

It may be of interest, therefore, to consider some of the more important results obtained in regard to food-producing plants, and to indicate some of the difficulties which may impede future progress. Of food grains none is more important than wheat. The most marked achievement in wheat breeding is the production of a variety resistant, if not entirely immune, to the fungous disease known as Yellow Rust (*Puccinia glumarum*), as a result of the discovery that resistance to this disease obeys the Mendelian law of segregation. Once this was established it became a comparatively simple matter to transfer this character as an independent unit from the poor yielding Russian wheat "Ghirka," in which it was found, to a wheat suitable to the conditions of England. The variety "Little Joss," which was "made" in this way some ten years ago, is now well established in the Eastern Counties.

The possible economic value of this achievement becomes apparent if the enormous yearly losses caused by rust—perhaps not far short of 10 per cent. of the yield annually—are considered.

* Reprinted from *Nature*, dated 25th July, 1918.

other economic character that can be controlled in the same way is stiffness of straw, a matter of importance in those parts of the country, such as the Fens, where a weak-strawed wheat becomes "laid" in wet seasons. It is interesting to learn that a short, stiff-strawed variety known as "Fenman" has recently been produced which is likely to be largely adopted in the Fen country. But the possibility of greater additions to the food supply of the country is now in sight. It is well known that wheat is commonly a slow-growing plant; sown in late autumn or winter, it is harvested in August. Barley and oats, on the other hand, come to maturity more rapidly, and need not be sown until spring. There are, however, certain varieties of wheat which can be sown in spring, but, unfortunately, their yield of grain is considerably less than that given by winter wheats. The result has been that under the ordinary conditions of farming in this country the area that can be sown with wheat is limited to that not occupied by a crop during winter. Barley and oats must be grown after "roots" because the latter are not completely off the ground until early spring. If, then, it were possible to make a spring wheat combining the character of early maturity with a yield approaching that given by winter wheat, the economic gain might be enormous, for, obviously it would be in the interest of home food production to curtail the area occupied annually by barley. If, then, we could add to the existing acreage sown annually with wheat only one quarter of the normal acreage under barley and oats, we should add probably 20 per cent. to the home-grown cereals available for human food. The possibility of making an improved spring wheat depends upon how far early maturity and yielding capacity are found to segregate. Apparently, there are indications that the former does, but the problem in regard to the latter is complex, depending for its solution on the clearing up of the difficulties that are encountered in dealing with quantitative characters, such as yield, as distinct from qualitative characters, such as colour of grain.

The questions involved are obviously of great economic importance, for it is the quantitative characters that often determine the economic value of a plant or animal. But it is not simply a

question of the universality of the Mendelian law. If, as some geneticists hold, the inheritance of quantitative characters is regulated by a complex of unit characters, the practical application of Mendelian principles becomes exceedingly difficult, for with any number of characters over three the number of possible combinations of unit characters becomes generally too large to handle. And the difficulty does not end there, for, owing to environmental fluctuation, the comparative genetic behaviour of individuals cannot be disentangled, and the plant breeder is consequently driven to resort to purely empirical methods of selection. Nevertheless the fact that the exact nature of the laws regulating the inheritance of quantitative characters is still obscure may not seriously impede the work of the practical breeder. In fact, it has been found in practice that, provided desirable qualitative characters can be built up in the desired complex, the quantitative characters may be susceptible of improvement by selective methods of a more or less empirical nature.

But when all is said, scientific plant improvement in Great Britain has made only a small beginning, due, no doubt, in part to the general excellence of the varieties of economic plants now established in this country. The "Improvers" of agriculture and horticulture in the nineteenth century revolutionized the industry and, as an outcome of their activities and influence, British seedsmen largely by selective methods, effected very great improvements in economic plants. It is only comparatively recently that this country has fallen behind. Allusion may be made to the great advances achieved in Sweden as a result of the work of the Svälof plant breeding station. Denmark also is forging ahead, but, curiously enough, progress has not been remarkable in Germany, owing perhaps, to the extraordinary cult of Darwinism which prevails there, and the consequent belief in the effectiveness of mass selection. In America considerable progress has been made from a scientific as well as from an economic point of view—notably in producing a cotton immune to the destructive wilt disease.

But if a striking object lesson of the successful application of new methods to plant production is needed, we must turn to

[illegible].[1] Dating from the foundation of the Pusa Research Institute [illegible] the beginning of the present century, great developments in the [illegible]ific exploitation of Indian agriculture have taken place. Much [illegible] is due to Lord Curzon, who, aided, it is now curious to recall, by the munificent bequest of an American (Mr. Phipps), founded a department which, it is no exaggeration to say, has added thousands, and will add millions, to the wealth of the country. India undoubtedly presented a fine field for the modern plant breeder. If we consider the immense variety of her plant products, their value either as food or in the arts and industries, and then observe that, owing to the absence of any skilled seed production industry, there is an uncounted number of identifiable races within each distinctive variety of economic plant, we can form some conception of the possibilities which even selection presents: superadding hybridization, it is difficult to assign any limits to the field that is opening out.

It would be impossible in the ordinary limits of space to give a detailed account of what has already been achieved, but some indication may be given of proved successes in relation to the more important economic plants.

Mention may first be made of wheat, of which upwards of 30 million acres are grown, and which was naturally one of the first crops to receive attention. Both selection and hybridization have been brought into action, and several new varieties are now firmly established. In the United Provinces in 1917 alone "Pusa No. 12" occupied 100,000 acres, and was extensively grown in the Punjab as well. This wheat gives a cultivator an *increased yield of 25 per cent.* over the varieties formerly grown by him, as well as nearly one shilling per quarter more on the market, owing to its improved quality. Another and later production of Pusa has on occasions given a yield of nearly fifty-five bushels per acre, which for India is an unheard-of figure, and may be compared with thirty-two bushels, the British average yield of wheat. In the Punjab another

[1] Report on the Progress of Agriculture in India for 1916-17. (Calcutta: Supdt Govt. Printing India, 1918.)

new variety occupied 97,000 acres, and it is estimated that th growers of this wheat were presented with an additional incom of nearly 15,000*l*. In the Central Provinces improved varieties returning to the cultivators considerably increased profits, occupie 200,000 acres. Remarkable progress is also being made in th production of improved varieties of rice, the most important cerea crop in India. A variety known as "Indrasail," isolated by pure line selection, occupied 20,000 acres in Bengal. In the Centra Provinces it has been necessary to establish thirty seed farms for th production of other new varieties. Turning to non-food produc we find that extraordinary advances have been made in regard cotton (of which 20 million acres are grown in India). In Sur an improved cotton has been produced giving a premium value 13 per cent.; in Sind new varieties are giving a premium of 23 p cent. In the Central Provinces a new introduction is estimated occupy no less than 800,000 acres, and to have brought the cul vators increased profits of nearly 900,000*l*. After this we may pa over such relatively inconsiderable figures as 215,000 acres und a new variety in the Punjab, but, for its human interest, mentio may be made of one incident in a campaign directed to the erad cation from a certain district of an inferior indigenous variety. I is a good example of the methods adopted to impress the Orienta imagination. "In the Tinnevelly District the department had t resort to drastic action for the control of seed in the case of some ninety acres of *pulichai* (the inferior cotton).....the seed fro this cotton was publicly burnt.....before a large gathering o ryots."

In the improvement of jute (of which India exports annuall products worth £40,000,000) some notable advances have bee made. It is expected that in the present year more than 30,000 acre will be sown with a new selected variety as a result of the distributio by the department of 500,000 packets of seed. In this connectio a valuable scientific discovery may be mentioned. The pernicious weed, water hyacinth, which infests the waterways of Bengal, ha been found to have a high potash content, and is consequently a valuable manure for jute, the use of which not only directl

imulates yield, but also protects the plant against a *Rhizoctonia* isease which attacks it.

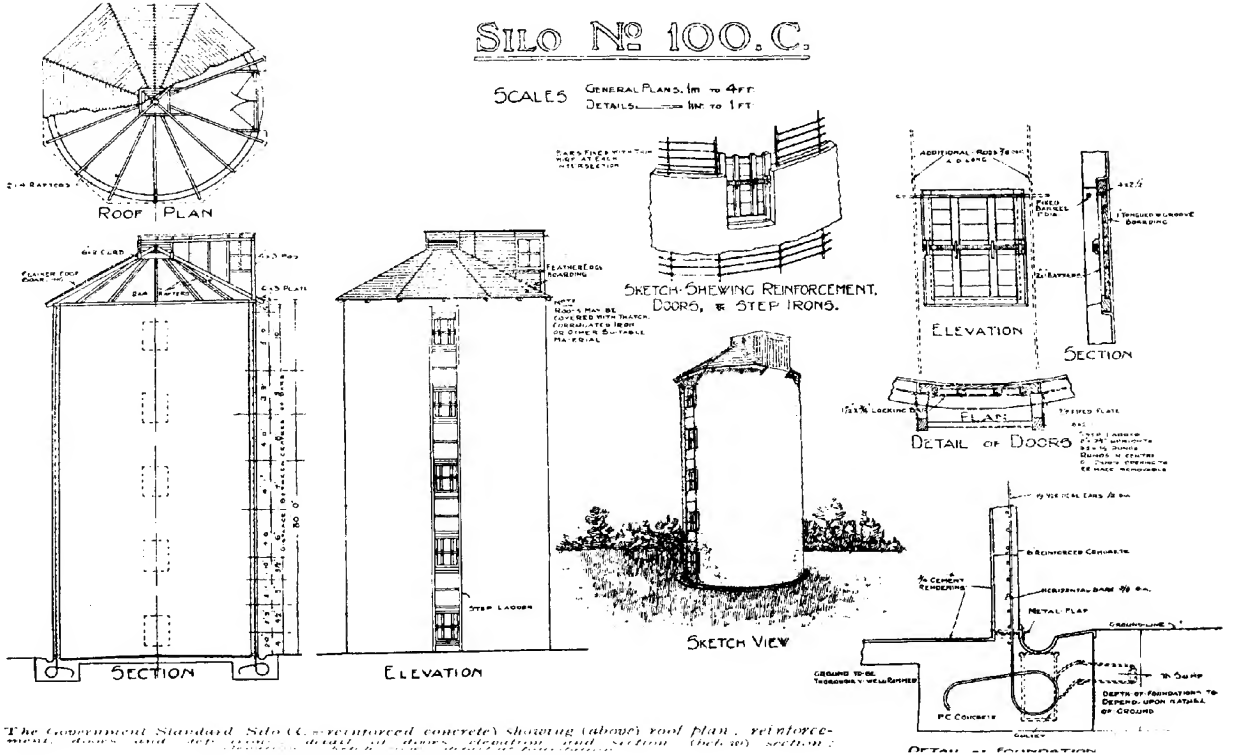
It will be readily admitted that this tale of economic progress is tonishing. No mention has been made of the purely scientific sults achieved, and they are very considerable. The workers no ubt feel well rewarded by the satisfaction with which they must gard the additions to knowledge which they have made, but ey may also feel some pride in the remarkable economic advances hich their labours have brought about, especially in regard to the od-producing plants.

THE GOVERNMENT'S STANDARD SILO.*

EARLY in the present year (1918), on January 12th to be exac we published a leading article dealing with the need for ensilage th must ensue from the conversion of so much pasture land into arabl Apparently it hit the nail on the head. There followed muc interesting correspondence from those directly interested in th method of preserving summer herbage for winter food. Inc dentally it disclosed great differences of practice and opinion. O one point alone was there unanimity. Every practical stock-owne felt that, as the contraction of grazing space synchronized with serious and increasing scarcity and dearness of feeding stuffs, th silo must now enter on a new career of usefulness. Previously had been the custom to discount its free use in Canada and th United States by pointing out that in these countries the length an severity of the winter compelled farmers to stable their livesto and feed indoors for a larger portion of the year than is necessa with us. But the circumstances arising out of the war caus them to drop this excuse for indifference. It was disclosed that to greater extent than had been generally known those farmers wh recognized that agricultural success depends upon taking long view had been quietly preparing to make ensilage. Enquiry on our pa showed that the movement had been most pronounced in th Eastern Counties, where the root crop is very uncertain, and tha Mr. Amos, whose successful management of the Downing Colleg land is very well known, had given special attention to the subject Fortunately, we were able to induce him to write a series of article that proved to be valuable and instructive.

Meanwhile, the Board of Agriculture, through its Food Produc tion Branch, had taken the matter up seriously. Previously th

* Reprinted from *Country Life*, dated 18th May, 1918.



The Government Standard Silo (C.=reinforced concrete) showing (above) roof plan, reinforcement, doors and step irons, details of doors, elevation and section (back to) section;

ubject, without being ignored, had from time to time been agitated, but not in a manner that attracted much attention. At any rate, no successful attempt had been made to get silos erected on British farms. From time to time official articles had been published, calling attention, indeed, to the advantages of making ensilage and giving instructions how to set about it, but altogether lacking in workable proposals for translating academical teaching into the general practice of husbandry. But the question was now tackled in a more purposeful spirit. An expert was engaged to visit and report upon silos in actual operation. Conferences were held to compare and estimate the relative advantages of different types, and finally standard plans were drawn up and are now made available for all who wish to erect silos of their own (Plate II). They will be disseminated by a machinery originally produced to deal with war agriculture. In other words, the County Executive Committees are called upon to promote the object in view. Plans and specifications are to be placed on view in the offices of each Committee, open to inspection by all who are interested. Also a little pamphlet has been drawn up for distribution. This clear and concise document should prove most serviceable. Standing alone on the first page is the sketch of a reinforced concrete silo for one hundred tons, and on the next a corresponding sketch of the reinforced brick silo for holding fifty tons—the former suitable for a herd of twenty-five cows, and the latter for a herd of twelve cows. Then follow the terms of the offer made by the Department, which are five in number, and are offers of (1) expert advice; (2) free supply of full working quantities, drawings and specifications; (3) loan of form and centering (moulds) and facilitating use of permit for materials; (4) estimating for complete construction of silos at a fixed price; and (5) assisting with any type of size other than the standard one adopted.

In considering this very encouraging offer, it would be well, in our opinion, to keep two considerations in mind. Whatever arguments may be advanced in favour of a wooden in preference to a concrete or brick silo, do not affect the difficulty of obtaining the timber with which to build it. That is a difficulty which apparently has decided the Department to say nothing about this type of silo.

Again, a very large number of our correspondents wrote with admira-tion of the rough-and-ready stack silo which in many cases has been enough to serve the purposes of the holding. Now, a stack silo is better than none, and in these times a man often has to consider less what he would like than what he has at disposal. Therefore it would be wrong to discountenance any method of increasing the home-grown and home-preserved food for livestock. But the stack silo is very uneconomical for permanent purposes—it is attended by a too serious decrease in solids. Two very useful sizes have been chosen, one 15 ft. in diameter by 30 ft. in height, capacity 5,300 cubic feet, holding about 100 tons of ensilage. The other is 24 ft. in diameter by 24 ft. in height, with exactly half the capacity of the other. Each type can be built either in reinforced brick or reinforced concrete.

We must not omit some reference to the last page, which is filled with a table of advantages of silage, very tersely and clearly put, each point being a maxim in a nutshell. The first four refer to it being a means of preserving green fodder for the winter, being independent of weather, being more certain on heavy clay land than root crops, and being cheaper than root growing under unfavourable conditions. The next two are directed to the growing of silage as a catch crop or a cleaning crop; the last four relating to the economy of labour and time which is secured by the use of the silo. They form an excellent set of precepts, well fitted for their purpose which is the dissemination among those who are in any way likely to wish to build a silo for their own use.

We have no doubt that the number of those who wish to do so will exceed what is possible this year, owing to the difficulties connected with labour and material. Every stock breeder, and especially the cattle breeder, will find that under the new system of agriculture now inaugurated and not likely to be given up or even to be radically changed in our time, the silo will be an indispensable adjunct to the farm.

AN IMPROVED TYPE OF COTTON FOR THE SOUTHERN MARATHA COUNTRY.

BY

G. L. KOTTUR,

Cotton Supervisor, Southern Division, Bombay Presidency.

COTTON is the most important crop in the black soil tract of the Southern Maratha Country, and covers an area of one to one and a half million acres in the districts of Dharwar, Belgaum, and Bijapur of the Bombay Presidency. The adjoining cotton-growing areas in the Madras Presidency and in the Native States of Kolhapur, Miraj, Sangli, Hyderabad, and Mysore present similar physical features and grow the same variety of cotton. The problems for solution in connection with cotton are therefore the same for the whole of this tract.

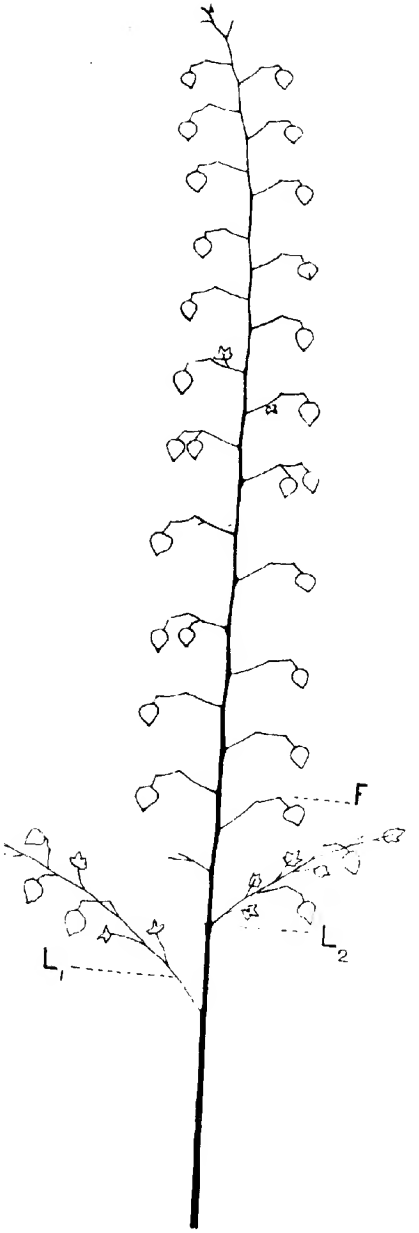
Except for a comparatively small area under Dharwar-American cotton, the whole of this tract grows a variety of *Gossypium herbaceum*, known in the local vernacular as *jowari-hatti*. It is botanically identical with Broach cotton, but agriculturally it differs in many points. It is a late sown cotton producing seedy *kapas* only one-fourth part of which is lint. The latter reaches the spinners under the name of Kumpta cotton. It is suited to spin 30's, and therefore ranks high in the list of long-staple *desi* cottons. We have in India few long-staple cottons, and the few that we have are in danger of being ousted by short-staple varieties. In the Southern Maratha Country, however, conditions are unfavourable to the growth of short-stapled varieties, and the tract is recognized as essentially a long-staple tract. Many other long-stapled cottons, both Indian and exotic, were tried in Dharwar, but

without producing any sustained success, and the only cotton brought from outside the tract that has survived the ordeal is the Broach cotton grown from Navasari seed, which has established itself in a limited area where conditions are favourable, and is still grown to the extent of a few thousand acres. Cross-fertilization also was tried, but out of a large number of hybrid cottons produced almost all have been finally discarded as unsuitable, and none has yet been regarded as suitable for introduction. Selection from the local variety was therefore the only method left by which improvement might be secured.

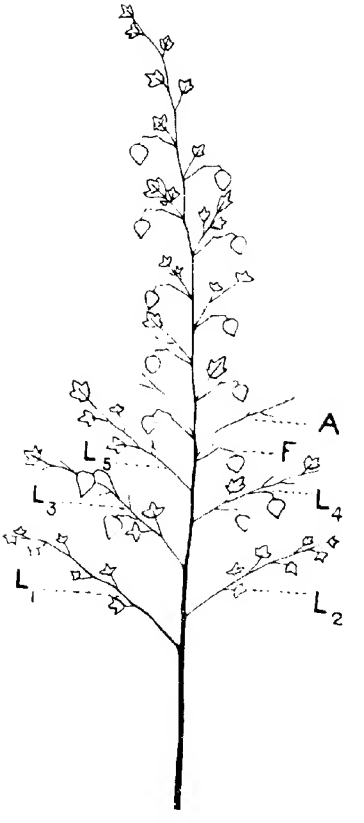
Now what are the characteristics of the local cotton (*jowari hatti*)? It is sown in August-September, and is ready for the first picking by February-March. It is a stunted plant with a small average outturn of *kapas* per acre and a low ginning percentage (25%). The average outturn of *kapas* is taken at 320 lb. per acre giving 80 lb. of lint. The staple, though long, is uneven and often weak. These defects gave an indication as to the directions in which improvement was indicated.

All *herbaceum* cottons produce a number of extra-axillary vegetative branches or limbs from the lower portion of the central stalk. These limbs take off from the main stalk at an angle of 45° and function exactly like the main stalk. At each node above the limbs, the main stalk bears two kinds of branches—(1) extra-axillary or fruiting, and (2) axillary or vegetative. The fruiting branch takes off at right angles from the central stalk, and at each node it slightly changes its direction of growth and produces a pedicel bearing a solitary flower. The vegetative branch behaves like the limbs, takes off at an angle of 45°, grows straight, and directly bears no fruits, but produces secondary fruiting branches. Now a study of the local cotton shows that there are two distinct types to be found, the erect type and the bushy type (Plate III). The erect type is characterized by the meagre development of limbs and vegetative branches. It grows tall and from each node produces a prominent fruiting branch. The bushy type, on the contrary, has from 5 to 10 limbs, and of its branches it is the vegetative ones that are prominent and vigorous, while the fruiting branches on the main stalk

PLATE III.



Erect type



Bushy type

Diagrammatic representation of the two types of *Jowari-hatti* cotton.
L - limb; F - fruiting branch; A - axillary branch.

are mostly suppressed and insignificant. In each case these characteristics are hereditary. The economic significance of this differentiation lies in the fact that it is the fruiting branches on the main stalk which first bear fruit, next the limbs, and last of all the vegetative branches. This difference would be immaterial if the environment were equally favourable to the reproductive activity of a plant throughout its growing period. But such uniformity is not obtained, for in the months of February and March there is a marked tendency for the late flowers to fall off. To secure yield, therefore, it is necessary to select the early flowering plants, that is to say, the erect type. Continued field tests have shown the superiority in yield of this erect type, and by sustained unit selection we have now got a plant which yields 12 per cent. more *kapas* than the local cotton; a *kapas* which yields 12 per cent. more lint than the local *kapas*, and lint which is valued at 5 per cent. more than the best Kumpta cotton available in the market.

The following report of Messrs. Forbes, Campbell & Co., of the Gokak mills, who kindly made the spinning test of our cotton, testifies its importance in the spinning industry of the future :—

"The cotton was considerably superior to any of the Kumpta cottons as supplied either direct or by the ryots or which we have obtained from the near markets. It is bright, light, clean, long in staple and uniform, and of middling strength. From it we spun three counts, *viz.*, 20's, 30's, 40's. The yarn ran smoothly and demanded very little attention from the work people, and we would no doubt have received better results, had we had sufficient cotton to make it worth our while to alter our machinery, so that it would be spun into yarn under the best conditions."

It is proposed to multiply and distribute seed of this improved type, and it is believed that by this means the economic condition of the cotton-growers will be materially improved and the spinning value of the Kumpta cotton will be enhanced.

CO-OPERATIVE SOCIETIES AND MARKETING OF COTTON*

BY

THE HON'BLE MR. PURSHOTAMDAS THAKURDAS, M.B.E.

IT is very usual to hear people swearing at cotton merchants on the ground that they buy *kapas* (unginned cotton) from cultivators very cheap and generally buy it before it is ripe to be marketed. In my written evidence to the Indian Cotton Committee I said as follows on the score of the cultivators' agency for marketing of *kapas* in the districts and on the score of the system of advances :—

"Regarding the system of the cultivators' agency for marketing of *kapas* in the districts, this also varies in various districts. The intelligent cultivator of the Surat and Broach districts does not, as a rule, employ an agent to sell or market his *kapas*. If he does not or cannot sell his *kapas* from his residence, he markets it himself and sells it off to the highest bidder on that day. He recovers the cash for it immediately. On the other hand, the ryot of the United Provinces or Khandesh sends his *kapas* to his *aratiya*, or commission agent, for sale and pays him a commission for the same. These *aratiyas*, wherever they are influential and wealthy, are *aratiyas* or commission agents for buyers also, and this dual capacity of theirs exposes them to a considerable temptation.

"*System of advances*. The system of advances to cultivators on their *kapas* divides itself into two chief parts.

"The first is advances against standing crops before the crops are matured and the other is advances against actual *kapas* when marketed. Regarding the first, this system is generally known as *jalap* and means the ryot estimating the outturn from his field and selling the same to the *sowkar* (money-lender) at a rate equivalent

* A paper read at the Co-operative Conference held at Bombay in April 1915.

to anything from Rs. 30 to Rs. 100 per *candy* (784 lb.) of cotton lower than the rate prevailing in Bombay. Against this sale the *sowkar* advances him 50 to 100 per cent. of the cost of the *kapas* so bought. The risk of such a buyer is twofold. Firstly, the risk of unforeseen ruin of the crop quantitatively, and, secondly, the risk of unforeseen damage to the quality of the crop by untimely rain or frost. This system was very prevalent twenty years back. The Deccan Agriculturists' Relief Act considerably discouraged this practice, but it still prevails to a fair extent.

"There is a good deal to be said against this practice of *jalap*. But in recent years when the prices of cotton may be said to have broken records of anything up to the last fifty years, the ryots themselves have shown great anxiety to avail themselves of rates which appear to them to be very high. All that could be suggested on this score is that co-operative credit societies should undertake what the village *sowkar* does, and should retain the margin for themselves in exchange for the risk that *jalap* operations entail on the buyer. As a matter of fact, I have not yet been able to comprehend why the various co-operative credit societies have not done so till now in their districts.

"The second mode of advances is the ordinary method of advances against *kapas* brought to the market, and I am not aware of any particular disadvantage to the ryot in this."

It will be perceived that as long as the Indian cultivator continues to be in a position where he must have money before the crop is ripe to be marketed in the normal course, some sort of accommodation is necessary for him. It need not be doubted that the *sowkar* giving him this accommodation makes the best of his opportunity to exact terms compatible with the risk he runs in making advances to the cultivator. I wish to suggest that people interested in the co-operative movement should turn their attention to replacing the *sowkar* or the cotton merchant with co-operative credit societies. It is well known that these advances to cultivators have to be made in the months of July to November when money is fairly easy everywhere, and it is not likely that co-operative credit societies will find any difficulty in securing money. What would be very necessary

to have is persons well-versed in cotton business to ensure that the co-operative credit societies' selling of cotton against a cultivator's *jalap* sale of *kapas* fetches the highest rate available either in that district or in Bombay with smallest risk regarding class, etc., to the seller. When this is organized it would mean that the cultivator selling his *kapas* would get that day's fullest market rate, and he would only have to pay interest until his *kapas* is actually delivered to the buyer. So much for improvement that can be effected in the cultivators' more or less necessary method of selling his crop before maturing.

Regarding the first paragraph of the quotation from my evidence given above, I think that even when crops are marketed after maturing, it is very necessary in some of the cotton-producing districts in India to have a co-operative credit society's agency for each day's *kapas* arrivals in each market. If this be organized with the help of reliable men on the staff of such agencies a lot of annoyance and petty losses to cultivators can be avoided, and looking to the increasing acreage under cotton all over India it would appear most necessary to organize such selling agencies in some of the important districts at least where there are no proper arrangements for independent weighment, etc., of the cultivators' produce. A good deal is being heard this year from well-meaning people not intimate with conditions and customs of the cotton trade regarding cotton merchants looting the cultivators. I have seen handbills asking cultivators in the district not to deliver *kapas* against their comparatively lower rate sales.

This is not the place to discuss the advisability or otherwise of such recommendations to cultivators, but this surely is the time to organize some sort of agency to keep cotton cultivators in good touch with the course of the cotton market in Bombay and abroad.

SUGAR AS A COAGULANT FOR *HEVEA* LATEX.*

BY

RUDOLPH D. ANSTEAD, M.A.,

Deputy Director of Agriculture, Planting Districts.

EATON and Grantham[1] found that if *Hevea* latex is allowed to stand in tall cylinders without the addition of any coagulant a slimy alkaline surface scum is formed, whilst the lower layers become acid and coagulation occurs in them. The surface changes are putrefactive in character and are brought about by organisms which are favoured by aerobic conditions.

The changes in the deeper parts of the liquid were considered by the authors to be due to activity of aerobic organisms. Both classes of bacteria were supposed to infect the latex after collection from the trees.

Whitby and Campbell showed that coagulation is not due to bacteria but to an enzyme, but that the putrefactive changes are due to bacteria, which by producing an alkaline medium, may destroy the enzyme and arrest coagulation in favour of putrefaction. Barrowcliff[2] brought forward a large amount of evidence to support this theory of coagulation and show that it was due to a specific enzyme.

In order to eliminate to some extent the predominance of the putrefactive changes and encourage the non-putrefactive ones, cane sugar and glucose were added to latex, and it was found that with each of these complete coagulation was obtained and

* Reprinted from the *Planters' Chronicle*, dated 10th August, 1918.

[1] Eaton and Grantham. *Agri. Bull., F. M. S.*, IV, 2 (1915). *India Rubber Journal*, I, 16, p. 340.

[2] Barrowcliff. *Jour. Soc. Chemical Industry*, XXXVII, 3, p. 48T.

putrefactive changes were inhibited. With pure crystalline dextrose it was found that as small a quantity as 0·2 per cent. calculated on the latex, was sufficient to bring about complete coagulation within 18 hours, and this coagulation took place most readily in closed vessels filled with latex so as to exclude the presence of air. The dextrose was completely decomposed and the coagulum was full of bubbles of carbon dioxide. Similar results were obtained with cane sugar, lactose, arabinose, mannose, and lævulose.

Subsequent experiments showed that if the temperature was kept low, below 40° to 50°F., coagulation was inhibited, but if the temperature was allowed to rise to 84°F. coagulation became complete.

At a time when there was a shortage of acetic acid it was suggested in the F. M. S. that cane sugar might be used as a substitute. A number of experiments were carried out in Java and the result of trials made at the Central Rubber Station for testing was that the difference between rubber coagulated by acetic acid and that coagulated by sugar were insignificant.[1] Tensile strength, slope and viscosity are nearly always the same, but in the rate of cure a small difference is generally found, the sugar coagulated rubber curing slower or quicker as the case may be.[2]

This means that with a running sale contract the change from acetic acid to sugar would nearly always mean a change in the rubber delivered which, unless warning was given, must be considered undesirable.

On this point Dr. O. de Vries[3] issues a word of warning, namely, not to change the coagulant before being convinced that it will not change the quality of the product. He points out that a new coagulant may often influence the rate of cure and so inflict serious losses on manufacturers and again awake their former distrust of plantation rubber. Manufacturers are now accustomed to certain characteristics in plantation rubber and have arranged

[1] Gorter and Swart, "Mededeelingen Rubber proefstation West Java, 6." *Agric. Bc. F. M. S.*, V (1916), p. 48.

[2] *Monthly Bulletin of Agri. Intelligence*, Rome, VIII, 10 (1917), p. 1421.

[3] *India Rubber Journal*, LII, 21, p. 744.

their treatment accordingly. A change in these characteristics without warning would be the cause of great trouble to them. A conservative policy is therefore advised by de Vries, who thinks that no change should be made before the peculiarities of the new coagulant have been thoroughly investigated. Every planter's ideal should be to sell his rubber under his own trade mark, by preference to one and the same buyer. This would be the surest way to fetch the highest prices and to obtain the best market. It will be obvious that such a customer would not be at all pleased at receiving unexpectedly a lot of rubber of different quality.

In general, however, and for the open market, the small difference in rate of cure can form no objection to sugar coagulated rubber. The difference is well within the limits which are generally found for ordinary first latex crepe. In three series of experiments the uniformity from day to day was not less with sugar coagulation than with the ordinary acetic acid coagulation.

The advantages and disadvantages of sugar as a coagulant may be summed up as follows:—

The great advantage is the cheapness of the material as compared with acetic acid, especially at the present time, while moreover it is always available in the country and does not depend upon shipping facilities. The quantity required is very small, 0·1 to 0·2 per cent. of sugar calculated on the latex, or one part of sugar to 500 parts of latex.

The disadvantages are first of all that it produces a product which differs slightly in rate of cure from acetic acid coagulated rubber, necessitating in the case of contracts a warning of the change to the buyers.

Another objection is that the coagulum is apt to be full of gas bubbles due to the evolution of carbon dioxide during the coagulation process, and sheet rubber suffering from this defect is looked on with disfavour in the market although the actual quality of the rubber is not affected by the presence of the bubbles. If crepe is being made, the bubbles of course do not matter, but sheet is chiefly made now.

Probably any drastic change in methods of coagulation likely to be adopted in the near future will tend towards what is known

as the M. C. T. process in which no coagulant is used at all, and by means of which a standard rubber can be made whatever the source of the latex.[1]

This process is based on the fact that in *closed vessels* latex coagulates completely without the addition of any coagulant and without putrefactive changes taking place. As carried out in practice, large cement tanks, provided with heavy water sealed lids, are used. Into these the bulked latex is poured, leaving the smallest possible air space above it. To each 100 gallons of latex, a quantity of calcium acetate equivalent to 4 oz. of calcium may be added if desired to accelerate the process. The covers are placed in position and sealed, and the whole is left undisturbed for three days when coagulation is complete. The resulting coagulum is converted into crepe in the usual way.

For the manufacture of sheet, iron pressure vessels are used, divided into partitions with aluminium sheets, and the coagulation takes place under a pressure of one or two atmospheres, which keeps the carbon dioxide evolved in the process in solution, and the resulting coagulum is free from bubbles and can be made into sheet.

[1] Barrowcliff *Jour. Soc. Chemical Industry.* XXXVII, 6, p. 95T.

Notes.

SELECTED CAWNPORE-AMERICAN COTTONS AND THEIR COMMERCIAL VALUATIONS.

In a previous number of this Journal[1] it was stated that, while Cawnpore-American cotton, as it then existed as a field crop, yielded well under irrigation and produced a cotton which found a ready market, there existed a considerable margin for improvement by selection in regard to yield, ginning percentage and uniformity of staple. The isolation of pure races was therefore taken up in 1912. Progress reports on this work have been given in the annual reports of the Cawnpore Experiment Station, and the detailed results are being published separately. As, however, a certain measure of success has been attained it may be of interest to summarize the main features here.

In 1912 a number of different types of Cawnpore-American cotton were selected from the field crop, selfed seed obtained (cross fertilization being prevented by covering the plants with mosquito nets), and the resulting progeny studied through several generations —with the necessary precautions to prevent crossing. In this way a number of races were obtained differing considerably in agricultural characters, in ginning percentage, and in lint. A large number of these races were discarded in the course of this work on account of unsatisfactory lint, low ginning percentage, excessive length of vegetative period, imperfectly hairy leaf (and consequent susceptibility to attack by aphis with the subsequent "red leaf" damage) or unsuitable habit. By 1916 a series of likely races had been obtained which were then tested for yield and ginning percentage on a field scale and for which, through the courtesy of Messrs. Tata & Sons, we were able to obtain commercial valuations of the cotton which were of the greatest value in deciding what types to retain.

[1] *The Agricultural Journal of India*, vol. VIII, pt. IV, 1913.

Through the kindness of Mr. Hodgkinson of the Indian Cotton Committee, arrangements were made for the valuing of several of these cottons, from the 1917 crop, in England, and the report of the expert brokers to the British Cotton Growing Association is as follows :—

Per lb.

"Ca 1 22·00 *d.* Good colour, about good middling in grade, staple 1 to $1\frac{1}{16}$". Rather mixed.
"Ca 5 21·50 *d.* Rather dull, barely good middling, $\frac{7}{8}$" to 1" staple.
"Ca 7 24·50 *d.* Good middling, strong and silky, staple $1\frac{1}{8}$."
"Ca 9 24·50 *d.* Good ,, strong and silky, staple $1\frac{1}{8}$."
"Ca 11 21·50 *d.* Good ,, good colour, 1" to $1\frac{1}{16}$" staple.
"Ca 18 24·50 *d.* Good ,, good colour, $1\frac{1}{8}$" staple.
"Ca 26 23·00 *d.* Good ,, good colour, $1\frac{1}{16}$" staple.
"All based on July American futures 22·00 *d.* per lb.
"Good middling American 21·56 *d.* ,, ,,

"The Ca 7, 9 and 18 are very good and are cottons which could be used extensively in Lancashire, and if India could produce an quantity, there should be an excellent demand. Of course you will understand that prices are abnormal and that it would not always be possible to obtain a basis of 250 points on for such cotton Probably 70 to 100 points on would be nearer the mark. No. Ca 2 is also a good cotton, and could be used, but not to the same extent as the others. These qualities are, of course, a great improvement on the samples of Punjab-American 4 F."

As regards the order of merit of the various cottons, this report entirely bears out Messrs. Tata & Sons' valuations.

The British Cotton Growing Association's report on the unselected Cawnpore-American of the 1912 crop, which is reproduced here for convenience, stated as follows :—

"302 Cawnpore (American). Equal to about low middling in grade, rather dull, staple $1\frac{1}{8}$", silky, strong but irregular."

Not only are the races Ca 7, 9 and 18 superior to the original in grade, which might be due to better handling and ginning, but the staple has been maintained and the irregularity complained of removed.

It may be explained that the other races, though known to be somewhat inferior to the others in staple, were all retained for

pecial reasons until further field trials had been made. No. 11 is n exceedingly early flowering type, Ca 5 is a very prolific yielder nd has a high ginning percentage, whilst Ca 1 is of a larger habit han the others and has yielded exceptionally well in certain years.

The accurate comparison of a series of cottons for yield is ecessarily a matter of some years, especially with seasons so variable s are experienced in Cawnpore. The monsoons of 1915-17 were ntirely abnormal, rainfall being excessive and cotton yields over he greater part of the province unsatisfactory. Not only did this amper work by reducing the amount of seed available for the ucceeding years' work but the results themselves require confir- nation in more favourable years. It can, however, be stated that a 7 and Ca 9 (and Ca 5, Ca 11) have given yields well above the verage in unfavourable years. Ca 18 may possibly prove unsuitable or Cawnpore owing to its longer vegetative period and late maturing.

In ginning percentage Ca 7 (33 per cent.), Ca 9 (33 per cent.), a 5 (34-35 per cent.), and Ca 11 (33 per cent.) are superior to he original field crop (30-31 per cent.).

It has been proved that given an adequate irrigation supply or timely sowing and adequate marketing arrangements Cawnpore- merican cotton can be profitably grown around Cawnpore. Among he above-mentioned pure races we have apparently cottons suited o Lancashire requirements. Incidentally, we have generally been ble to obtain adequate prices for Cawnpore-American cotton from awnpore mills.—[B. C. BURT.]

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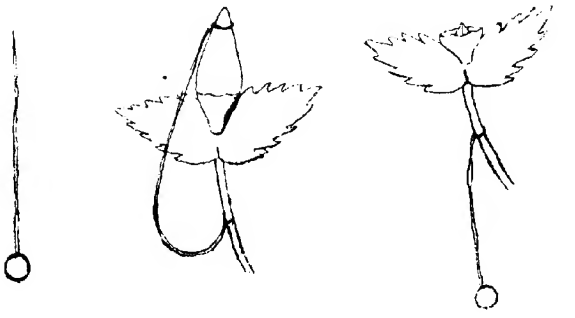
NOTE ON PROTECTING COTTON FLOWERS FROM NATURAL CROSSING.

NATURAL crossing takes place in all cottons to a greater or less xtent, and its seriousness has been demonstrated and admitted in ll countries. The Indian varieties cross freely with each other. nd when these are grown together in breeding plots or in compara- ve trials, care is necessary to maintain them pure. For the same easons all promising strains evolved from single plants must be rotected. In fact the danger from natural crossing is so great that very seed allowed to ripen in the usual manner is of doubtful origin.

Natural crossing can be prevented by growing the cottons in bee-proof cages. It may not be, however, possible to provide such cages, and, moreover, they are unnecessary in many cases when only a small quantity of the pure seed is needed. Single plants can be protected by netting; but the netted plants attract the jackal and are damaged by them. They also suffer seriously from the attack of aphis. Under these circumstances, it has been found very convenient to protect a few flowers on every plant required pure for propagation.

The usual method of protecting the flowers is to cover them by means of small paper bags. Bagging presents certain difficulties. The paper used should be strong enough to bear the beating of the surrounding branches, especially when the wind is blowing hard. The tying also should be done carefully, otherwise the bag goes off the flower. The expense and trouble in making the bags and putting them on to the flowers is also considerable. Taking these things into consideration, another method was tried by the writer last year and was found to be very effective. Rings made of thin wire were employed in place of paper bags. These were put on the fully developed buds before they commenced opening. The form of the flower being a cone, there was no difficulty in putting the rings tight and these prevented altogether the opening of the petals. Further the stalk of the protected flower was marked by a piece of cotton thread attached to the ring. The following figures illustrate the method :—



The method is easy, simple and inexpensive. It herefore claims general application on all farms where the ecessity of maintaining the varieties pure is felt.—[G. L. OUPUR.]

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IN the Kohat District of the North-West Frontier Province, here grows wild the **dwarf-palm** ***(Nannorhops Ritchieans)*** known ocally as *mazri*. In one tahsil alone the area occupied is estimated t about 100 square miles, and the total annual production of leaves t about 500,000 maunds or about 8 maunds per acre. Like the ocoanut palm of the West Coast, *mazri* plays an important part in he economic life of the people of the district, for no portion of it oes without use. Its leaves produce an excellent fibre for preparaion of sandals, cordage ropes, floor and roof matting, baskets for ousehold use, punkhas, skullcaps, brooms, etc.; its dry leaves are sed for lighting fires and its fruit is eaten. There is also a considerble demand for *mazri* articles in other parts of the Frontier Province nd in the Punjab, and in addition to the local production valued t about five lakhs of rupees, *mazri* articles of the aggregate value f Rs. 1,22,203 were imported during 1915-16 from the Kurram alley, Tirah, and Kabul. As stated above, *mazri* in the Kohat istrict grows wild and is not cultivated, and the manufacture of ibre articles is carried on in a more or less haphazard manner. In iew of the considerable industrial possibilities of the palm, Babu am Sarup Dutt, of Kohat, submitted a paper to the Indian Indusrial Commission, giving a history of the present condition of the rade in *mazri* and embodying suggestions for its commercial xploitation on a wider basis. He has supplied us with a copy of is paper, and we notice that he suggests the utilization of *mazri* eaves as a substitute for other costly fibres, for manufacture of aper, pasteboard and brushware, and for articles of household se such as chairs, suit cases, hat boxes, meat safes, tiffin baskets, loor mats, etc. His suggestions are based on the fact that similar

varieties of dwarf-palm are put to these uses in other countries, but he acknowledges that much investigation is necessary. Considering the backward condition of the province, Babu Ram Sarup suggests that Government should pioneer the industry, and if the experimental factory is found a commercial success, it may be made over to a private body under proper Government control. He believes that there would be no dearth of labour, for the discharged sepoys of the Kohat District will be available in numbers. What interests us specially is the writer's suggestion that experiments may be made as to whether *mazri* can be cultivated as a field crop and that attempts may be made to extend its area. This would naturally follow if the claims made on the industrial side are justified by results, for as Babu Ram Sarup himself says, "once the zemindar comes to realize that the plant is coming to be counted as a plant of great commercial value, he will leave nothing undone to promote its growth." If it is to remain a cottage industry, the sovereign remedy for all its ills lies in Co-operation, to which the energies of the public-spirited people of the district might be usefully directed.—[EDITOR.]

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BY-PRODUCTS OF SUGAR MILLS IN FORMOSA.

SUGAR factories in Formosa generally work for six months in the year, from the middle or end of November to May, though in years of good crop work may extend for seven or eight months, from early in November to the end of May or June. For the rest of the year no work is done other than repairs.

According to information supplied by H. M. Commercial Attaché at Yokohama, the molasses produced is manufactured into alcohol and "Tomitsushu," the latter appearing to be a liquor somewhat similar to rum, and which is used by Formosans. There seems to be but little molasses wasted, though a considerable quantity has been exported to China and Japan or sold locally.

The following table gives the quantity of molasses, alcohol d "rum" (Tomitsushu) in recent years :—

Year	Output of molasses	Quantity used for alcohol	Quantity used for "rum"	Total
	*Kin	Kin	Kin	Kin
12-13	59,325,018	20,573,360	32,810,810	53,384,170
13-14	42,951,244	12,619,247	19,418,488	32,037,735
14-15	37,234,126	22,631,125	17,852,451	40,483,576
15-16	77,612,097	63,328,048	17,981,514	81,309,598
16-17	140,478,843	99,461,425	21,546,532	121,007,957

*Kin=1·323 lb. av.

The above figures are supplied by the Bureau of Productive dustries, but it is evident from the totals that considerable quanies of molasses must at times be carried forward to the next year.

There are no special Government regulations controlling or tricting the fermentation of molasses, other than the general governing the manufacture of saké. The alcohol and "rum" oduced are liable to taxation.

No molasses is thrown away. Occasionally when there is a ortage of fuel, molasses may be poured over crushed cane, which then used as fuel.

At times molasses has been used for cattle food. So far, wever, there has been no excess really available as a regular tle food.

A certain quantity of molasses is exported to Japan and China, the former by the sugar mills, and to the latter by Formosans.

The quantity of such export in recent years has been as lows :—

Year	Export to Japan	Export to China, etc.	Total
	Kin	Kin	Kin
12-13	4,443,153	843,931	5,287,084
13-14	2,559,776	247,687	2,807,463
14-15	433,360	1,053,429	1,486,789
15-16	65,290	6,294,095	6,359,385
16-17	1,650	11,796,668	11,798,318

The manufacture of alcohol and "rum" is not regarded as by-production of the mills. The business is conducted separate though it is not stated whether separate amounts of capital a allotted to the molasses business. The percentage of producti of molasses has been stated to be 27 kin to 100 kin of sugar, a the prices of molasses have fluctuated between 3·30 yen* per kin a 0·40 yen per kin with an average of 0·60 yen to 0·70 yen per kin. [*The Board of Trade Journal*, dated July 11, 1918.]

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HOME SUPPLIES OF POTASH.

It seems quite probable that the United Kingdom, after t war if not earlier, will be in a position to supply itself with potas and so become totally independent of German and other sourc from which we drew to a very considerable extent in pre-war da Of course we have no natural potash deposits such as those whi exist at Stassfurt in Saxony, and are sufficient to supply the nee of the whole world, but potash is present in many things, and n least in blast furnace dust. As the result of experiments in Nor Lincolnshire it has been found possible by the addition of a sma quantity of common salt to the furnace burden to extract potas in considerable bulk at practically little more than the cost of t salt. With the financial support of the Government a factory ha been built and equipped at Oldbury, near Birmingham, capabl of an output of 400 to 500 tons of potassium chloride per wee and it is part of the scheme, according to the *Board of Trade Journ* to erect also a conversion factory, where the chloride not needed for agricultural purposes may be converted into refined potas salts. Other factories in the neighbourhood of blast furnaces i Cleveland and elsewhere are reported to be in contemplation. I is estimated that 50,000 tons per annum could be made available at an economical cost. Great Britain requires now about 30,000 tons of potash fertilizer, besides smaller quantities for the glass soap, dye, match, and other industries annually. Before the wa we imported potash compounds to the value of one and a thir

* Yen = 2*s.* 0½*d.* at par.

million pounds (£1,380,567 in 1913), of which 66 per cent. was derived from Germany and the remainder from France, Russia, British India, Belgium, etc. The cessation of imports from Germany created a serious position for England, but the difficulty has been overcome by importing enormously increased quantities of nitrate of potash (saltpetre) from India, and various compounds from elsewhere. The need even for this is now disappearing to some extent, as a result of the development of home production. Germany placed great reliance upon her State-managed potash business, the sales of which in 1913 had a value of over ten millions sterling, and by reason of this had also a practical monopoly of optical glass manufacture.—[*The Economist*, dated September 21, 1918.]

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THE PRODUCTION AND VALUE OF ARTIFICIAL RUBBER.

It is reported from Germany that the well-known chemical and dye firm, Farbenfabriken vormals Friedrich Bayer and Co., in Laverkusen, has considerably extended its works for the purpose of manufacturing artificial rubber. The history of the German effort to produce this substitute dates before the war. The early attempts had perforce to be given up when the price of natural rubber fell from 30 to 4 marks per kg. After the outbreak of war, when the rubber shortage in Germany became acute, it was impossible to continue the pre-war output of artificial rubber, since the necessary plant had long since been scrapped and the requisite raw materials, acetone and aluminium, were not to be had. Before long, however, both these commodities began to be produced in increasing quantities. Coal and carbide yielded acetone, and the production of aluminium was undertaken on a large scale, with the financial assistance of the State, especially by the Griessheim-Elektron concern, which in conjunction with the Metallgesellschaft set up three buildings for the purpose. After these preliminaries the manufacture of artificial rubber could be resumed. Hard rubber was comparatively easy to produce, but the production of soft rubber presented much difficulty. The news that additional

artificial rubber factories have been opened, however, makes appear probable that there has been progress in this field. T great question is, can artificial rubber compete with natural rubbe The answer varies with the use to which the substitute is pu Quite generally, however, according to *Vorwärts*, a doubt may l expressed as to whether synthetic rubber can stand the test, esp cially in view of the present selling prices, which are many tim greater than the prevailing prices on the London rubber market. [*The Board of Trade Journal*, dated September 26, 1918.]

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THE second annual **sale of surplus stock from the pedigre Montgomery and Ayrshire-Montgomery herds** was held **at Pusa** on Mo day, the 9th December, 1918, when 34 head fetched Rs. 5,70 under the hammer, an average of Rs. 167 per head all through.

	Average price.
	Rs.
Montgomery bulls	.. 203
Montgomery bull-calves ..	.. 132
Montgomery heifers ..	.. 140
Montgomery cows	.. 164
Montgomery-Ayrshire bull-calves	.. 234

The bidding was very keen and there was specially a keen demand for cross-bred bull-calves as the figures show. The next sale will probably be held in March 1919.—[WYNNE SAYER.]

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

SIR EDWARD MACLAGAN, K.C.S.I., K.C.I.E., I.C.S., some time Officiating Member in charge of the Revenue and Agriculture Department of the Government of India, has been appointed Lieutenant-Governor of the Punjab, *vice* Sir Michael O'Dwyer, G.C.I.E. We offer him our sincere congratulations.

***

WE offer our hearty congratulations to Major (Temporary Lieutenant-Colonel) F. S. H. Baldrey, F.R.C.V.S., formerly of the Indian Civil Veterinary Department, who has been admitted a Companion of the Most Distinguished Order of St. Michael and St. George for services rendered in connection with the war.

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MAJOR (HONORARY LIEUTENANT-COLONEL) JOHN WALTER LEATHER, V.D., has been permitted, on resignation of his commission in the United Provinces Horse, to retain his honorary rank.

***

HIS MAJESTY THE KING-EMPEROR has graciously granted to Mr. Ernest Shearer, formerly of the Indian Agricultural Service, and at present of the Egyptian Ministry of Agriculture, authority to wear the decoration of the Order of the Nile (Third Class) granted to him by the Sultan of Egypt in recognition of valuable services.

***

HIS EXCELLENCY GENERAL SIR CHARLES MONRO, in his despatch dated 20th August, 1918, on the work done in India during the first three years of the war, mentions the names of the following, among others, for particularly valuable services rendered by them :—

Lieutenant-Colonel G. H. Evans, C.I.E., A.D.C., Indian Defence Force ;

Lieutenant-Colonel H. T. Pease, C.I.E., V.D., India Defence Force ; and

Lieutenant-Colonel G. K. Walker, C.I.E., F.R.C.V.S. Indian Defence Force.

***

CAPTAIN (TEMPORARY) G. C. SHERRARD has been mentioned by Lieutenant-General W. R. Marshall, Commanding-in-Chief, Mesopotamia Expeditionary Force, in his despatch dated 15th April 1918, for distinguished and gallant services and devotion to duty.

***

MR. A. HOWARD, C.I.E., Imperial Economic Botanist, and Mrs. G. L. C. Howard, M.A., Second Imperial Economic Botanist, were on privilege leave for six weeks from 21st October, 1918.

***

DR. HAROLD H. MANN, Principal of the Agricultural College, Poona, has been appointed to act as Director of Agriculture, Bombay Presidency, *vice* the Hon'ble Mr. G. F. Keatinge, I.C.S. (on deputation), pending further orders.

Mr. J. B. Knight, M.Sc., Professor of Agriculture, Agricultural College, Poona, acts as Principal, *vice* Dr. Harold H. Mann, pending further orders.

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THE designation of Mr. H. M. Chibber, M.A., Second Economic Botanist, Bombay, has been changed to "Plant Breeding Expert to the Government of Bombay."

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MR. P. C. PATIL, L.Ag., Acting Deputy Director of Agriculture, Northern Division, Bombay, has been granted privilege leave for three months. Mr. B. M. Desai, Assistant Professor of Dairying, Agricultural College, Poona, has been appointed to act during Mr. Patil's absence.

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RAI BAHADUR K. RANGA ACHARIYAR, M.A., Lecturing and Systematic Botanist, Agricultural College, Coimbatore, and Mr. J.

Chelvaranga Razu, Acting Deputy Director of Agriculture, IV Circle, Madras, have been admitted into the Indian Agricultural Service with effect from 6th June, 1918, and 29th May, 1918, respectively.

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THE services of Mr. Daulat Ram Sethi, M.A., B.Sc., Deputy Director of Agriculture, Orissa Circle, have been placed at the disposal of the Durbar of the Kapurthala State in the Punjab for three years.

Mr. S. K. Basu, M.A., Assistant Professor of Mycology, Sabour College, has been appointed to act as Deputy Director of Agriculture, Orissa Circle, during the absence, on deputation, of Mr. Sethi, or until further orders.

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MR. W. YOUNGMAN, B.Sc., has been admitted to the Indian Agricultural Service and appointed Assistant Economic Botanist in the United Provinces.

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MR. E. A. A. JOSEPH, B.A., I.C.S., Director of Agriculture, Punjab, has been appointed to officiate as Revenue Secretary to the Government, Punjab, and Mr. S. M. Jacob, I.C.S., officiates as Director in Mr. Joseph's absence.

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MR. F. J. WARTH, M.Sc., Agricultural Chemist, Burma, who was posted to duty with the Mandalay Battalion, Burma Military Police, has reverted to the Agricultural Department.

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MR. C. P. MAYADAS, M.A., B.Sc., Assistant Director of Agriculture, Western Circle, Central Provinces, has been transferred in the same capacity to the Northern Circle.

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THE Government of India have approved of the recommendation made by the Board of Agriculture in India in December 1917 that sectional meetings of the Board should be held in years in

which there is no full meeting of the Board, and the following sectional meetings have been arranged for this year :—

Section	Place of meeting	Date
Entomological Section	Pusa	3rd February, 1918, and following days.
Mycological Section	Pusa	20th February, 1918, and following days.
Chemical Section	Pusa	24th February, 1918, and following days.
Veterinary Section	Lahore	24th March, 1918, and following days.

Reviews.

A Survey and Census of the Cattle of Assam.—By J. R. BLACKWOOD, LL.B., I.C.S., Director of Agriculture, Bengal. Calcutta: The Bengal Secretariat Book Depôt, 1916. Price Rs. 3-11 or 5*s.* 6*d.*

At the suggestion of the Government of India that a report on the survey and census of cattle in each province should be prepared on the lines somewhat similar to the Punjab report on the subject issued in 1910, the late Eastern Bengal and Assam Government selected Mr. Blackwood for this duty in November 1911. After the redistribution of the provinces he was instructed to prepare separate reports for Bengal and Assam. A review of the report for the former province has already appeared in the *Journal* (vol. XII, pt. IV). It is the report of the latter province that forms the subject of this review.

According to the census, the number of cattle in Assam is 4,840,348, of which, approximately, one-tenth are buffaloes. The proportion is roughly 7 head of cattle to every 10 inhabitants. This is considerably higher than the proportion in Bengal. Within the province itself the ratio in various districts differs greatly. In the Surma Valley which is comparatively thickly populated and where a great part of the land is submerged deeply for several months in the year so that cattle have to be stall-fed, 1,808,287 cattle have been enumerated, roughly, 1 to every 3 human beings. In the Assam Valley, where there are many unoccupied areas and unlimited grazing, over three millions of cattle of all sorts (3,032,061) have been found, a number not far short of the whole human population of the tract.

The breeds of cattle in Assam can be conveniently divided into three classes :—

(1) Wild cattle.

(2) Hill cattle.

(3) Cattle of the plains.

The wild buffalo is found throughout the swampy Terai of Assam. Among hill cattle, those* in Manipur are generally superior to the ordinary village cattle of the plains. In the Naga Hills people do not use their cattle for ploughing or carting; they never milk the cows but use cattle solely for food. In the Jaintia Hills a very good class of animal is found. The Garos also do not drink milk, nor do they breed cattle themselves. They generally buy bull-calves from the Nepali *bastis* in the district or in the plains, fatten them and then either kill or sell them.

The poor quality of the cattle in the plains is well known, and is largely due to climatic conditions combined to a great extent with the usual ignorance and apathy peculiar to indigenous cattle breeding, coupled with neglect, starvation, inbreeding and the usual anti-castration attitude.

In many parts during the rains the cattle stand continuously in mud and water and are fed on paddy straw. This state of affairs does not suit cattle, though it is all right for buffaloes. As a matter of fact the poor quality of the Assam cattle is in marked contrast to the fine quality of the Assam buffalo. The average milk yield of an Assam cow is less than that of a Bengal cow, being under a seer per day. The best of the local bullocks are considered by the cultivators good enough for the plough, but for heavy cart work fairly big strong animals are required and they are usually imported from Bihar districts. Improvement in the milking capacity of the cow, and better draught power in the case of bullocks are therefore required. It is possible to bring this about by crossing with suitable breeds.

In 1902 an experiment was started on the Upper Shillong farm of crossing Khasi and Bhutia cows with a bull of the Taylor (Patna

* Particularly the bullocks, which are good draught animals.

evil. The female offspring of the cross showed much better milk suits. Whereas a pure Khasi cow, it is said, will give only two er of milk per day, the cross-bred animal gives as much as ven or eight seers per day. A pure Bhutia cow is reported to ve only four seers of milk per day, while the cross-bred gives six ers.

Pure bred Patna bulls are given out by the Department in the ohussil, but the chief difficulty is to get the people to feed the ills properly after they are sent out.

The Government of Bengal have established a cattle-breeding rm at Rangpur (which is on the borders of Assam) where experi-ents have been undertaken to determine whether the improvement the local breeds is to be by rigid selection of indigenous cattle r crossing with exotic breeds, such as Montgomery, and as the roblems in Assam are somewhat analogous to those in Bengal, recent Resolution of the Local Administration states that it is roposed to wait and see the issue of the experiment there before oing in for any scheme of large cattle-breeding farms. In the eantime animals from the Rangpur farm will be obtained by the epartment for employment as sires in the province.

The practice of growing fodder crops for cattle is practically on-existent at present in Assam. This is mainly due to the fact at, with the exception of a few thickly populated districts where ll the land not taken up for rice is flooded, Assam is better off for razing than many other provinces. In the more densely populated ortions of the province, however, the provision of grazing for attle already presents a serious problem, and the difficulty is rowing year by year. Accordingly steps have been taken by the ocal Administration to set apart lands for grazing and protect hem from encroachment. These grazing reserves are of four main lasses :—

(1) Village grazing grounds in which agriculturists' cattle graze free of charge ;

(2) grazing grounds in more remote localities, where profes-sional graziers may keep large herds, paying the pres-cribed fees ;

(3) grazing grounds in the vicinity of small towns, where cattle kept for the supply of milk to the towns pay a reduced scale of fees; and

(4) village forests in which grazing may be allowed in accordance with the rules for the management of the forest.

The quality of the cattle found in any tract does not depend merely on the abundance or otherwise of grazing, but on climate and several other equally important factors, and it is clear that ultimately the ryot in Assam will have to take to growing fodder crops. Most parts of Assam are too wet for *jowar* (*A. Sorghum*), and until a suitable substitute is found or means devised of storing grass in the form of hay or ensilage, the cattle will have to depend very largely on pasture. In the opinion of the local authorities sufficient area therefore, must, wherever possible, be kept as grazing ground. Up to now over 130,000 acres have been reserved for the purpose in the Assam Valley, and over 20,000 acres in the Surma Valley. This will not go far towards the support of some four million head of cattle, but in the more populated parts where such ground are needed, it is already difficult to get suitable land.

With the growing demand for milk and other dairy produce and the consequent rise in their prices, the benefits of selective breeding and proper feeding of cattle, the necessity of introducing suitable fodder crops, and of devising means for preserving grass and other fodder, should be impressed on the people. It is hoped that the Agricultural, Veterinary, and Co-operative Departments, working together, will be able to effect a marked improvement on the present state of things.

***

Bulletin of the Imperial Institute, London, January-March 1918.—This issue contains a very important article of 40 pages on "The Material Resources of Burma" by Sir Harvey Adamson, K.C.S.I., lately Lieutenant-Governor of Burma. With a fertile soil, a rainfall that has never been known to fail, abundant fisheries, magnificent forests, and rich but hitherto almost unexplored mineral wealth, Burma might be expected to offer a promising field for commercial enterprise. Yet, with the exception of rice, teak, and

mineral oil, its products have not to a great extent attracted British pital. The chief reasons for this failure are dearness of labour d deficiency in means of transport. With an area three times as rge as Bengal, Burma has only about a fourth of the population of at province; consequently the wages of labour are twice as high s in India itself. The population of Burma is rapidly expanding oth by natural increase and immigration. It would expand still ster, says Sir Harvey Adamson, if the second great deterrent to e influx of capital were removed, and Burma were equipped with dequate railways and roads. To serve an area nearly twice the ze of the United Kingdom, Burma has only 1,598 miles of railway. he length of metalled roads in the whole province is put down on aper as 2,100 miles; but most of these roads are not worthy of the ame. Outside towns and their environs there are few roads that re fit for other than bullock-cart traffic, and very few miles where otor traffic is possible. The provincial contract given to Burma 1907 was quite inadequate for the equipment of the province with ecessary public works, and though the contract has since been ugmented by the sum of 15 lakhs of rupees (£100,000) a year, ir Harvey Adamson considers it still insufficient to meet the quirements of the province within a reasonable time. He gives articulars of the crops, agricultural stock, fisheries, forest products d minerals, all leading to the conclusion that Burma is a land of ch resources and great potentialities. There can be no doubt that pital judiciously expended, whether by Government in improving mmunications and developing natural resources, or by private terprise in exploitation, would be profitably employed. A hand-me return has been obtained from the capital already expended revenue-producing public works. Sir Harvey Adamson asserts at there is no truth in the opinion often expressed that overnment is adverse to private enterprise. In the interest of the x-payer Government is bound to reserve for itself a fair share of e profits earned from the exploitation of the products of the untry. Within this limit it welcomes and is ready to give priority private enterprise. Unfortunately applicants for concessions ve too often been adventurers who desire to take much and give

nothing in return, and who possess neither expert knowledge a sufficient capital to utilize the products which they wish to explo Such applications, Sir Harvey Adamson points out, must be rejecte but where *bona fide* applications for concessions are made by exper or capitalists, the Government of Burma is always ready to welcon them, and never turns them down without reasonable cause.

Among other articles in the Bulletin is one on natural dy stuffs. The scarcity of synthetic dyes since the interruption commercial relations with Germany has led to a search for n natural dye-stuffs and for new sources of supply of the better-kno materials. Many samples of such products have been received the Imperial Institute, and the results of their examination are giv in the Bulletin. The chief developments during the war have bee however, in the increased production of natural indigo in India a Java, and fustic in the West Indies. These two dyes are much demand for the blue and khaki cloths required for naval and milita uniforms. With regard to the future of natural indigo, it is point out in the Bulletin that the present demand will no doubt contin during the war; but the manufacture of synthetic indigo has bee started in the United Kingdom, the United States, France, Switze land and other countries, and after the war the natural produ may have to contend with even severer competition than in the pa

Correspondence.

IMPROVEMENTS IN THE QUALITY OF UNITED STATES COTTON.

THE EDITOR,

The Agricultural Journal of India.

I have just received the April issue (vol. XIII, pt. II) of the ournal. I was recently talking with Mr. Erwin W. Thompson, f the United States Commercial Department, best known for his ost excellent reports on vegetable oils and oilseeds. He gave me understand that, speaking generally, improvements in the quality United States cotton had hitherto practically always centred und some particular large estate, the owner of which was able to ow a large quantity of his particular selection and was also in ch a financial position as to be able to sell his produce on a wider arket than the local one usually provided. Among the smaller owers who sell locally, similar results had not generally been tained and there had been a slight deterioration in such crops. perusal of Mr. Roberts' article in the Journal referred to seems corroborate this opinion, but Mr. Roberts does not so far appear state it categorically as a result of his tour of inspection. It uld be of interest if he could or could not corroborate this opinion, one point of great importance to India is a knowledge of any ethods adopted elsewhere, whereby improvements in the quality

of cotton have been effected and *maintained* among a large numb of small holders and growers.

Yours faithfully,

D. T. CHADWICK,

Indian Trade Commissioner.

LONDON :

5th July, 1918.

(*Enclosure.*)

DEAR MR. CHADWICK,

* * * * * *

Mr. Roberts says (page 278) : " The chief reason for Mr. Coke success is that he is a buyer of fine cotton and is able to give proj value for good staple." I happen to know Mr. Coker and his wo and I think the " chief reason " is quite exactly stated. T certainty that a cotton grower will get pay for his cotton in proport to its excellence is undoubtedly of more importance in the ultim improvement of American cotton than any other one factor, r excepting scientific breeding. I say " not excepting " because a matter of fact in the above circumstances scientific breedi would not permit itself to be excluded ; it would naturally follo Conversely, scientific breeding cannot succeed commercially unl the grower can see some financial advantage ; he takes no inter in the means, he wants to see the end.

The American producer usually sells his cotton in small villa to cotton buyers who are paid salaries or commissions by dealers large cities. Often there is a community of interests among th small buyers or at least a tacit understanding for buying the planter cotton at the lowest possible prices. If one small grower brings market a few bales of a most superior cotton he cannot obtain mo for it than his neighbour who has an inferior grade, for the villa price is usually based on an average for the district. As a natu consequence the small grower cannot afford to give the time a attention to quality, he works for quantity.

A large cotton plantation, say 50,000 to 60,000 acres, co afford to employ competent men to work for both quality a quantity. Proper machinery could be provided for cleaning a

le ing good sound planting seed. Prevention of outside
lu ization would be more easy because of the large area under
ntrol. The cotton seed produced could be worked in an oil mill
longing to the plantation. And, finally, the amount of cotton
oduced would be large enough to justify selling on its merits in the
rge markets where there is world competition. The greater prices
us obtained would give a commercial impetus to cotton betterment,
ot on the plantation itself, but by force of example, in the country
large.

* * * * * *

Yours sincerely,

LONDON. ERWIN W. THOMPSON,
American Commercial Attaché,
Copenhagen.

MR. ROBERTS' REPLY.

TO THE EDITOR,

The Agricultural Journal of India.

With reference to Mr. Chadwick's letter of 5th July, a copy
which you have kindly sent me, I beg to note that I can
nfirm Mr. Thompson's opinion quoted by the Indian Trade
ommissioner. The most marked example of wide improvement
came across, was in the County of Hartsville, S. Carolina. The
nprovement there was brought about by the work of the Pedigree
eed Company run by Mr. Coker, who is an influential man there.
e has been supplying improved strains now for over 12 years and
s changed the character of the cotton of the whole county, of
hich 95 per cent. now produces cotton of $1\frac{1}{4}''$ to $1\frac{3}{8}''$ staple as
mpared to barely 1″ previously. Mr. Coker has been able to do
is as he has been a buyer also, with an interest in production of a
perior staple. In the ordinary local markets a superior staple
rely gets a premium and hence progress has been spasmodic.

The two essential conditions for success with small holders are

(1) supply of seed from one source, which is continually improving; and

(2) organization of marketing to secure full value for the improved cottons from the start or as early as possible after its introduction.

The Punjab policy is based on this. In Egypt, they are not supplying seed on a wholesale scale as in the Punjab although markets are fairly well organized, but seed given out is best seed from estates and factories and not of any pedigree or definite stock.

With cotton where seed has to be purchased from outside in any case, there is no difficulty in maintaining the standard. The cost of seed per acre being so small, helps to make this easier.

Yours faithfully,

W. ROBERTS,

Professor of Agriculture.

LYALLPUR:

5th October, 1918.

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS.

Treatise on Applied Analytical Chemistry, by Prof. V. Villavecchia and others. Translated by T. H. Hope. In two volumes. (London: J. & A. Churchill.) Price 21*s*. and 25*s*. net.

The Practice of Soft Cheese-Making: A Guide to the Manufacture of Soft Cheese and the Preparation of Cream for Market. Fourth Revision, by C. W. Walker-Tisdale and T. R. Robinson. Pp. 106. (London: J. North.) Price 3*s*. net.

A Short Handbook of Oil Analysis, by Dr. A. H. Gill. Revised, Eighth Edition. Pp. 209. (Philadelphia and London: J. P. Lippincott Co.) Price 10*s*. 6*d*. net.

Plant Genetics, by J. M. and M. C. Coulter. Pp. ix+214. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press.) Price 1-50 dollars net.

Western Live-Stock Management, edited by Ermine L. Potter and others. Pp. xiv+462. (London: Macmillan & Co.) Price 10*s*. net.

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Common British Beetles and Spiders and How to Identify Them, by S. N. Sedgwick. Pp. 62. (London: C. H. Kelly.)

The Main Currents of Zoology, by Prof. W. A. Locy. Pp. vii+216. (New York: H. Holt & Co.)

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Bulletins.

The Improvement of the Indigenous Methods of Gur and Sugar Making in the United Provinces, by W. Hulme and R. P. Sanghi. (Bulletin No. 82.) Price As. 8 or 9*d.*

The Best Means of rapidly increasing the Outturns of Food Crops by Methods within the Power of the Agricultural Department. Being Notes submitted to the Meeting of the Board of Agriculture in India, Poona, 1917. Edited, with an Introduction, by J. Mackenna, C.I.E., I.C.S. (Bulletin No. 84.) Price As. 4 or 5*d.*

Moumachipalan, by C. C. Ghosh, B.A. (Bengali version of Bulletin No. 46 on "Bee-keeping.") Price As. 14 or 1*s.* 4*d.*, net.

Indigo Publication.

The Future Prospects of the Natural Indigo Industry. The Effect of Superphosphate Manuring on the Yield and Quality of the Indigo Plant, by W. A. Davis, B.Sc., A.C.G.I. (Indigo Publication No. 4.) Price As. 4 or 5*d.*

Reports.

Scientific Reports of the Agricultural Research Institute, Pusa (including the Report of the Imperial Cotton Specialist), 1917-18. Price R. 1-4 or 2*s.*

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